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Environments

(Level 4)

Teacher's Guide

Robert Knott
Chester A. Lawson
Robert Karplus
Herbert D. Thier
Marshall Montgomery

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SCIIS

Rand McNally & Company
Chicago • New York • San Francisco

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Student Manual Cover by George Suyeoka;
other illustrations by Jim Curran

Extending Your Experience Cards Bill and Judie Anderson;
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PHOTOGRAPHS

Teacher's Guide Alaska Department of Economic
Development—Division of Tourism; Tom England;
Charles Frizzell; Verna R. Johnston/Photo Researchers;
John V.A.F. Neal/Photo Researchers;
Ken Short; Lee Trail

Student Manual Tom England

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Contents

Preface: From SCIS to SCIIS / viii

An Introduction to SCIIS / x
- The Conceptual Framework / x
- Structure and Content / xiii
- Helping Children Learn with SCIIS / xvi

Environments: An Overview / 1

PART ONE Environmental Factors / 3
- **1** Review / 5
- **2** The Growth Race / 9
- **3** Environmental Factors / 13
- **4** Responses of Organisms / 15

PART TWO Changes Outdoors / 21
- **5** Recording Changes in the Environment / 23
- **6** Changes in Organisms / 27
- **7** Light and Plant Growth / 31

PART THREE Plant Responses to Environmental Factors / 37
- **8** Temperature and Plant Development / 39
- **9** Plant Responses to Water / 46
- **10** Plant Responses to Chemicals / 50

PART FOUR Animal Responses to Environmental Factors / 55
- **11** A Place to Live In / 57
- **12** Temperature and Isopods / 61
- **13** The Best Environment for Isopods / 65
- **14** The Environment of Land Hermit Crabs / 71
- **15** The Environment of Beetles / 78

PART FIVE The Total Environment / 85
- **16** Building a “Perfect” Habitat / 87
- **17** The Human Environment / 90

APPENDICES

Evaluating Your Students / 95
- Concept/Process Evaluation / 95
- Attitudes in Science / 102
- Perception of the Classroom Environment / 103

Glossary / 106

SCIIS Plants and Animals / 108

Design and Use of the Kit / 114

Schedule of Activities / 116

Preface: From SCIS to SCIIS

Over the past twenty years almost a hundred curriculum projects—the majority in science—germinated on the educational landscape. Some withered, some bloomed, and some not only thrived but went on to propagate successful offspring. Among the latter has been the Science Curriculum Improvement Study (SCIS), which grew out of Robert Karplus's early studies of elementary school children and science learning in the 1960s. Funded by the National Science Foundation, and eventually housed at the Lawrence Hall of Science, University of California at Berkeley, the SCIS program became one of several curriculum projects that have markedly changed the direction of elementary science education in the 1970s. After extensive testing with thousands of students and teachers, the first commercial edition of SCIS was published by Rand McNally in 1970–72.

The educational impact and acceptance of SCIS was rapid and widespread. The insights, commitment, and enthusiasm of the SCIS developers were passed on to the teachers using the program—directly and through workshops, in-service training, and visitation programs at the Lawrence Hall. These efforts were significantly reinforced by the publisher, who sponsored additional programs for teachers, set up information and awareness centers, provided consultants, and serviced thousands of schools with its representatives. In less than three years SCIS clearly established itself as a program to emulate. No other available materials provided science educators with so much flexibility in subject matter, classroom materials, and teaching strategy, within a clearly defined conceptual framework. No other program so explicitly set scientific literacy as its overall goal for children—and then earned the documentation (mostly from independent sources) to show achievement of that goal. No other program introduced children to the life sciences by bringing live organisms into the elementary classroom for direct observation and study. And no other program that focused on *doing,* rather than reading about, science was more widely adopted and used in the schools.

For these reasons, SCIS has been a challenging program and, at the same time, one that has been a pleasure to teach and to learn from. The challenge lay in the need for the developers, the publisher, and teachers to give something more in terms of time and effort, and to effectively create, deliver, and present to students the concepts and activities embodied in SCIS. For example, one of the salient and essential features of the program is the presence of live organisms in the classroom; the culturing, scheduling, procurement, use, care, and maintenance of selected plants and animals, no matter how hardy, required a commitment over and above that needed in a "read-about" science program.

On the other hand, that SCIS has been a pleasure to teach is a judgment that comes from thousands of educators and children who have used it. An overwhelming majority have told the publisher and the authors that student interest, enthusiasm, and achievement have been markedly increased in their classes—and not only in terms of science. Language and communication skills have improved, as supported by research. Ability and willingness to observe, measure, collect data, organize information, reason, interpret, and weigh evidence have been characteristic of SCIS learners. Anticipating and then witnessing these outcomes in the classroom helps to make teaching what it at least occasionally needs to be—a joyful experience.

During the 1975–76 school year Rand McNally invited approximately 500 elementary specialists and teachers using SCIS in a wide variety of locations and educational environments to review the materials and comment critically from their own experiences. They did so in person and in writing, and the resulting feedback has provided a basis for thorough revision by members of the original SCIS author team. Working together, the authors and the publisher began developing the new program you now have in hand. The task encompassed far more than merely remodeling the existing activities, books, and equipment. New activities, concepts, themes, learning components, design, packaging, sources of supply, delivery systems, and services to support teachers — these and other features of the new program were scrutinized and tested in schools or laboratories, and measured against the expressed needs of the schools.

The end result is the Rand McNally SCIIS program.

We are pleased with it. We are confident that it will provide you and your students with even greater opportunities for learning and enjoyment in science—and in ways related to other disciplines—than did its predecessor. And we want to hear from you about your experiences with it (see the Evaluation Response Form, drawer 1, in the kit).

Finally, our thanks to the many teachers, parents, and children who voluntarily gave us the benefit of their comments. We would like the reader to join them—as a user and as a friendly critic—in the ongoing task of improving science education, with SCIIS.

A note about the title and logo

We seem to be nearing a time when the supply of possible acronyms for educational programs, projects, and organizations will be exhausted. Rather than contribute to a further drain on the supply, we thought it singularly appropriate to retain much of what "SCIS" has been—in name as well as in substance. We saw the task as one of improving SCIS *from within* a conceptual and physical framework that had already proven itself in the classroom, rather than simply adding on from outside or giving the impression that we were starting from scratch again. Hence, SCIS became SCIIS, with another I inserted. And something resembling the original "snowflake" survives in the logo.

For the literal-minded, the new I may serve to represent further improvement, or more innovation, or (with its partner) a two (II). Thinking about and debating such fine points provided hours of recreation for editors, advertising staff, and project management. We would prefer that you call the program "Rand McNally SCIIS" to avoid confusion with the earlier SCIS or with other products now using a similar name.

For the Authors—	**For Rand McNally—**
Herbert D. Thier	**William Miller**

August, 1977

An Introduction to SCIIS

The Conceptual Framework

Diversity and change—in the landscape, in cloud formations, at the zoo, in a jar of sugar water forming rock candy—attract children's attention and awaken their interest. Curious about their surroundings, children naturally seek to describe and sort the diverse animals, plants, and nonliving materials they discover. In this respect they resemble scientists, who try to understand the basic conditions governing change.

THE GOAL: SCIENTIFIC LITERACY

Through investigation, scientists' understanding of nature advances from simple hypotheses to complex theories. Similarly, children's thinking advances from the concrete to the abstract as they accumulate experiences and ideas. They develop more effective techniques for observing and testing nature. In other words *they become scientifically literate*.

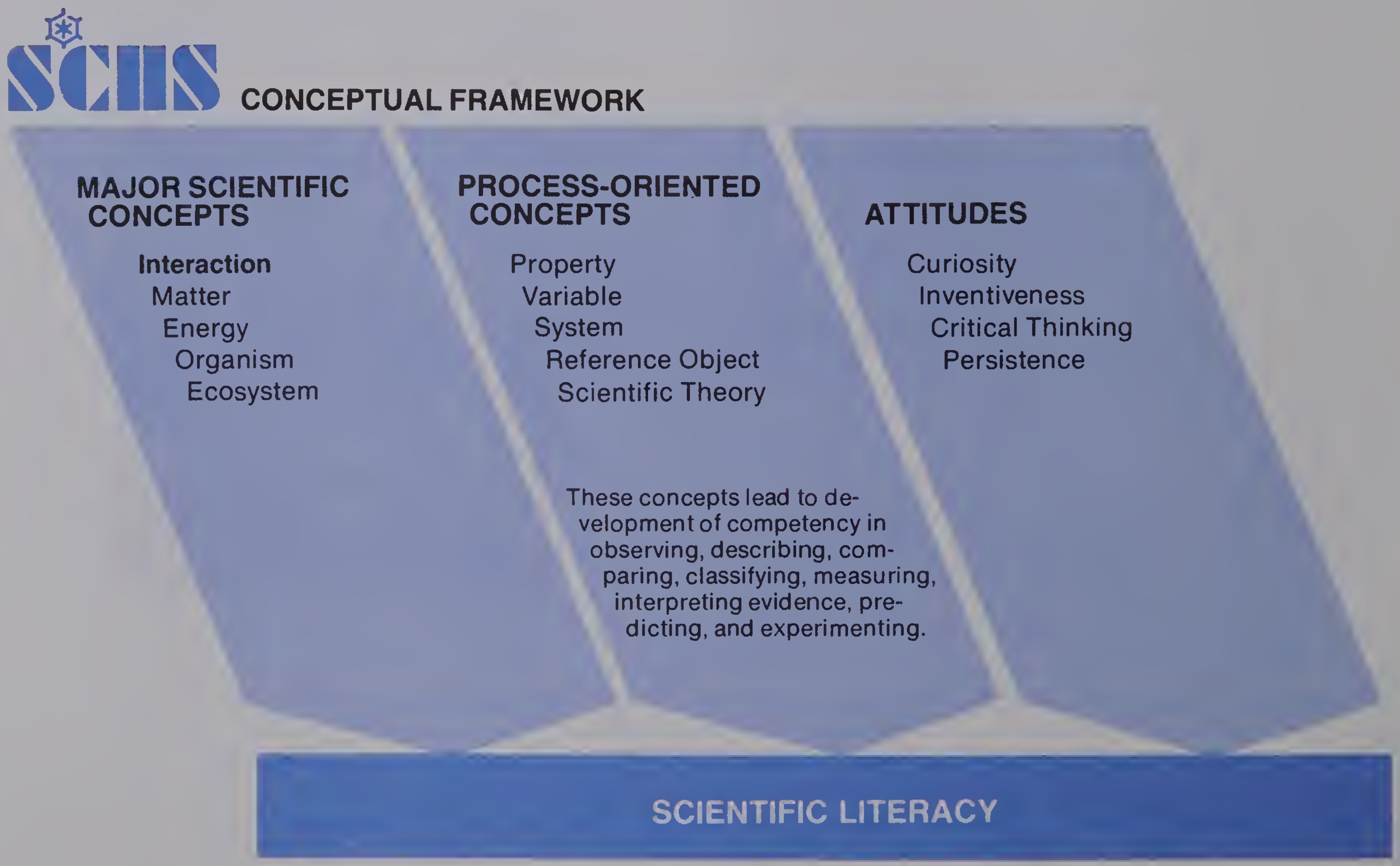
Scientific literacy derives from basic knowledge, investigative experience, and curiosity. In the SCIIS program, these three factors are integrated, balanced, and developed through the children's involvement with basic scientific concepts, process-oriented concepts, and challenging problems for investigation.

CONCEPTS, PROCESSES, AND ATTITUDES

Educators frequently distinguish among content learning, process development, and attitude formation when they describe an educational program or evaluate its outcomes. The SCIIS program combines these three factors into an integrated whole, matching the way children learn. Children are introduced to scientific content through firsthand experiences—with magnets, gears, fish, crickets, and a wide range of other living and nonliving materials.

In the course of their investigations, children engage in observation, measurement, interpretation, prediction, and other processes essential for the development of scientific literacy.

Finally, the SCIIS program helps children form positive attitudes toward science as they explore phe-



These concepts lead to development of competency in observing, describing, comparing, classifying, measuring, interpreting evidence, predicting, and experimenting.

nomena. Using their own ideas and preferences, children learn to cope confidently with new and unexpected findings by sifting evidence and forming conclusions—thus removing the "magic" from science.

Major Scientific Concepts *Interaction.* The concept of *interaction* is central to modern science—and therefore also to the SCIIS program. This concept embodies the scientific view that changes in nature take place because objects interact in reproducible ways when conditions are controlled. In the scientific view, changes do not occur because they are preordained or because a "spirit" or other power within objects influences them capriciously.

When objects or organisms do something to one another that brings about a change, we say that an interaction has occurred. When you clap your hands, they interact with one another and the air. The observed changes, the sensation in your palms, and the sudden sound are evidence of interaction.

Children can easily observe and use such evidence. They can watch a guppy eat a daphnia, hear bubbles when seltzer tablets dissolve, spin a compass pointer with a magnet, and detect the odor of decomposing organic materials. As they advance from dependence on concrete experiences to the ability to think abstractly, children can identify the conditions under which interactions occur and predict their outcomes.

In SCIIS, four major scientific concepts elaborate the interaction theme—*matter, energy, organism,* and *ecosystem*. Children's experiences and investigations in the six units that make up the physical/earth science sequence are based on matter and energy.

Organism and ecosystem provide the framework for the six units in the life/earth science sequence. Additional concepts are described in the appropriate Teacher's Guides.

Matter. Matter, or material, is introduced in the SCIIS program through the solids, liquids, and gases in the environment. These interact with human sense organs and with each other. Material objects can be described and recognized by their color, shape, weight, texture, and other properties. As children investigate changes in objects in the SCIIS physical/earth science sequence, they become aware of the diversity of interacting objects and their properties.

Energy. Energy is the inherent ability of a system to bring about changes in itself or in the state of its surroundings. Some familiar energy sources are the natural gas used to heat a kettle of water, the horse used to pull a plow, the unwinding spring that operates a clock, and the discharging battery in a pocket radio. The complement of an energy source is an energy receiver, such as the football kicked by a player or the ice cube placed in warm water. The interaction between energy source and receiver results in energy transfer.

Organism. An organism is an entire living individual—plant or animal. It is composed of matter, and it uses the energy from its food to develop, grow, and be active. The organism concept represents a fusion of the matter and energy concepts, but it is much broader than the sum of its parts. An essential factor is the organization of matter into cells and other structures that assure continuity of life from generation to generation.

Ecosystem. Awareness of the interactions between organisms and the environment leads to the ecosystem concept. As children observe living plants and animals in the classroom or out-of-doors, they notice the amazing diversity of organisms and their life cycles. They observe how plants and animals interact with one another and with the soil, atmosphere, and sunlight in the complex network of relationships that constitute an ecosystem.

Think of a forest as an example. A forest is more than an assemblage of trees. Living in the shade of trees are shrubs, vines, herbs, ferns, mosses, and toadstools. Dependent upon these plants and living among them are insects, birds, mammals, reptiles, and amphibians. The animals depend on plants for food, shelter, and other needs. The plants use sunlight, carbon dioxide, water, and minerals to make food that sustains themselves and other organisms in the forest.

Process-Oriented Concepts. By defining and emphasizing specific concepts, SCIIS permits teachers and pupils to concentrate on the objectives of the program. Five process-oriented concepts—*property* (or characteristic), *variable, system, reference object,* and *scientific theory*—underlie and are essential for development of competency in the processes of observing, describing, comparing, classifying, measuring, interpreting evidence, predicting, and experimenting.

Property. We have already referred to the properties by which an object may be described or recognized. A property is any quality that enables you to describe, compare, or classify objects. Color, size, shape, texture, and scent are properties of a blossoming plant; color, density, and hardness are properties of a mineral specimen; and size, color, and style are properties of a suit of clothes.

Properties also enable you to describe concepts. For example, duration is a property of a time interval; accuracy is a property of a carefully-made measurement; and the term climate (hot, cold, temperate) summarizes the properties of weather in a specific region.

Variable. Properties and conditions that differ from one experiment to another are important in scientific work, and they have been given a special name—variables. Examples are the temperature of water being warmed by the sun, the amount of fertilizer added to a potted ivy plant, the length of time a flashlight battery has been used, and the number of crickets feeding on a particular patch of grass.

System. System is a word that has entered everyone's vocabulary. We deal with the nervous system, communications systems, electronic systems, and systems analysis. In all of these a system is a whole made up of related parts. Earth and its moon form a system of two closely interacting bodies in space. A seed, moist soil in which it is planted, and air form a system. The system concept reflects the fact that objects and organisms do not function in isolation but exist in a context of interaction with other objects or organisms.

When one system is part of another system, it is called a *subsystem*. The earth, including its atmosphere, plants, and animals, is a subsystem of the earth-moon system. The seed, with its embryo, seed coat, and stored food, is a subsystem of the seed-soil-air system.

The terms object, subsystem, and system allow us to use three levels for grouping the elements that attract our attention in an event. We shall use the word "object" for individual pieces of matter, "subsystem" for intermediate groups of objects, and "system" for the largest collection under consideration.

We have concentrated on "closed" systems in the SCIIS physical/earth science sequence. A closed system is defined by the matter of which it is composed. Whenever matter is added to, removed from, or replaced by, other matter, the original system becomes a new system. When nothing is added or removed, a system retains its identity even though it may change in form or appearance.

Sometimes (especially in the life sciences) scientists find it useful to work with "open" systems, which are defined by the matter occupying a certain region of space. The air space within a terrarium is an example. In an open system there may be changes of matter without changes in identity—as when water vapor, carbon dioxide, and oxygen enter and leave the air even though the terrarium is covered. The ecosystems children investigate in Level 6 are examples of open systems. Children who continue to study science may learn to distinguish between open and closed systems when that distinction becomes important.

Reference object. The fourth process-oriented concept, reference object, helps children overcome the limitations of describing position and motion only from their own point of view. Space exploration has shown that we can no longer think exclusively in terms of up-down and north-south as defined on the earth. For young children—who at first relate objects only to themselves—the use of external reference objects is a challenge.

In SCIIS, the basic concept is simple: Position and motion of objects can be described only with reference to other objects, including (possibly) the body of the observer. When you say, "Meet me at the north end of the picnic area," you describe the location of the meeting place relative to the picnic area. In the example, the picnic area serves as reference object and the compass direction serves as reference direction. When you say, "The main entrance to the museum is to your left," you are using the listener's body as reference object.

The child who can take into account several reference objects and reference directions overcomes a spatially self-centered viewpoint. The concept of the earth as a sphere in space can be understood only in relation to a reference object not located on the earth itself; therefore an understanding of reference objects is fundamental to further work in earth and space sciences.

Scientific theory. An example of a scientific theory is the ray theory of light, which holds that light consists of rays propagating from a lamp or other light source to your eye or an illuminated object.

An everyday example of theory-building can be derived from a look at a common pay phone. How does the coin turn on the phone connection? One might imagine that the coin falls on and depresses a small platform, thereby closing a switch. What is your theory of how the coin turns on the telephone? Keep in mind that many phones work with a dime but not with a nickel, or with two dimes but not with three nickels, even though a nickel is heavier than a dime.

Scientific theories provide explanations for natural phenomena such as light, photosynthesis, weather, heredity, chemical combination, or the solar system. A theory usually postulates certain unseen relationships or objects, such as light rays emanating from a lamp, the platform in a telephone, or atoms in a material substance. Theories also lead to predictions and new discoveries about the events being investigated. If the predictions are not borne out, a theory may be discarded. By using scientific theories, children can relate present observations to previous and subsequent experiences with similar events.

Structure and Content

The SCIIS program consists of thirteen learning units in science for children at preschool, kindergarten, and elementary school levels. The introductory unit, *Beginnings,* leads into two six-unit sequences—the physical/earth science sequence and the life/earth science sequence.

The two sequences are complementary in that either of the two units for any one level may be used first. For example, at Level 1 you may use *Material Objects* in the fall and *Organisms* in the spring, or vice versa. This flexibility permits switching of units between two classes at midyear. (Supplementary and alternate packages of materials are available for schools wishing to switch units, to share unit kits among two or more classes, or to supply exceptionally small or large classes.)

The physical/earth science sequence guides children through carefully selected investigations of the physical world. In the same way, the life/earth science sequence focuses attention on the biological world. Both sequences include treatment of some topics relating to the earth sciences—shadow astronomy, map coordinates, water and mineral cycles, and climatic factors are examples.

SYNOPSES OF THE UNITS

Concepts and processes developed and emphasized throughout the SCIIS program have been described in the preceding "Conceptual Framework." The following summaries list the concepts and processes most important within each unit.

Level K *Beginnings*

Concepts and processes emphasized in this unit: color, shape, texture, odor, sound, size, quantity, position, organism.

The *Beginnings* unit for kindergarten and early childhood education offers a wide variety of activities and experiences in both life and physical sciences. Most of the activities are designed for use in small-group learning situations. Children learn to observe, discriminate, and describe, using objects and organisms in the classroom and outdoors. These early experiences help them develop language and participation skills and contribute to their growing understanding of science. The *Beginnings* unit leads into the physical/earth science and life/earth science sequences.

SCIIS STRUCTURE AND SEQUENCE OF UNITS

K BEGINNINGS

	Physical/Earth Science Sequence	Life/Earth Science Sequence
1	MATERIAL OBJECTS	ORGANISMS
2	INTERACTION AND SYSTEMS	LIFE CYCLES
3	SUBSYSTEMS AND VARIABLES	POPULATIONS
4	RELATIVE POSITION AND MOTION	ENVIRONMENTS
5	ENERGY SOURCES	COMMUNITIES
6	SCIENTIFIC THEORIES	ECOSYSTEMS

Physical/Earth Science Sequence

Level 1 *Material Objects*

Concepts and processes emphasized in this unit: object, property, material, serial ordering, evidence.

The children handle, observe, and describe objects. They learn that objects are composed of materials and have properties by which the objects can be discriminated; that some objects are solids, while others are liquids or gases; that objects can change; and that there are ways to recognize evidence of change. Property comparison leads to the concept of serial ordering. As the children investigate the properties of various materials, they realize that the same substance can exist in more than one form, and they gain an awareness of the principle of conservation of matter.

Level 2 *Interaction and Systems*

Concepts and processes emphasized in this unit: interaction, system, evidence of interaction, interaction at a distance.

The concept of interaction is introduced, as well as the concept that related objects or parts comprise a system. Students examine a variety of interactions, some of which are directly observable, others less apparent. The evidence that an interaction has taken place comes from the observed change in the system. The children investigate gear/pulley systems, chemical systems, magnetic systems, and electric circuits to observe and interpret evidence of interaction.

Level 3 *Subsystems and Variables*

Concepts and processes emphasized in this unit: subsystem, solution, evaporation, histogram, and variable.

The subsystem concept is introduced to give the children a grouping of objects intermediate between a single object and an entire system. The children's work with solid and liquid materials extends their understanding of the subsystem concept. They learn that filtering will separate an undissolved solid from a liquid, but that solids dissolved in solutions must be identified by the residue that remains after the liquid evaporates. Histograms are used to record and interpret data collected by the students. The variable concept helps them to identify and investigate factors influencing their experiments.

Level 4 *Relative Position and Motion*

Concepts and processes emphasized in this unit: reference object, relative position, relative motion, polar coordinates, rectangular coordinates.

The ideas and techniques developed in this unit are related to concepts of earth and space science. Students find that descriptions of position and motion are meaningful only if reference to objects and coordinate systems—both polar and rectangular—are included in the descriptions. An artificial observer, Mr. O, serves the children as an introductory reference object. They see that reference to different objects and coordinate systems leads to different descriptions of position and motion. Children also learn to use a variety of reference frames to describe both the position and the motion of objects in their everyday environment.

Level 5 *Energy Sources*

Concepts and processes emphasized in this unit: energy source, energy receiver, energy transfer, energy chain.

The concepts of energy source, energy transfer, and energy receiver constitute the core of the unit and are illustrated with experiments exploring mechanical and thermal systems. The importance of solar energy to meet some of our needs is emphasized in this unit. The children's descriptions of the amounts of energy transferred from a source to a receiver help to prepare them for understanding and applying the principle of conservation of energy.

Level 6 *Scientific Theories*

Concepts and processes emphasized in this unit: scientific theory, color, magnetic field, electricity, light ray.

The extended investigations and formulation of scientific theories in this unit conclude the physical/earth science sequence. In *Scientific Theories,* children create their own theories to explain their observations of colored light, magnetic interactions, electric circuits, and simple ray optics. Investigations provide opportunities for students to think of theories to explain the operation of systems of interacting objects and to devise tests to distinguish among alternate proposals. In doing so, they gain a deeper understanding of how scientists work.

Life/Earth Science Sequence

Level 1 *Organisms*

Concepts and processes emphasized in this unit: organism, birth, death, habitat, food chain, decay.

The stage is set for the unit as children plant seeds, watch the growth of the seedlings, and experiment to see how external conditions affect growth. Their observations are extended to a model ecosystem—an aquarium. They observe changes that occur in the aquarium, including the growth of plants and animals, animals feeding on plants, animals eating other animals, birth, death, and decay. Experiences with classroom plants and aquariums give children a general introduction to the overall theme of the life/earth science units: the interaction of organisms with their environments.

Level 2 *Life Cycles*

Concepts and processes emphasized in this unit: growth, development, life cycle, genetic identity, plant and animal, metamorphosis.

Attention is shifted from the ecosystem as a whole to some of its important parts—individual plants and animals. Through experiences with living, dead, and nonliving objects, the children have an opportunity to learn these classifications of objects around them. Living and dead organisms are further subdivided into plants and animals. By observing live, growing, developing, reproducing plants and animals, the children become aware of the fact that living objects have life cycles.

Level 3 *Populations*

Concepts and processes emphasized in this unit: population, plant-eater, food web, biotic potential, animal-eater, plant-animal-eater, predator-prey.

The children learn that the individual plants and animals they observed in previous units live as groups in nature. They build, maintain, and observe terrariums and aquariums, and they investigate the interactions of populations—food webs, for example—in each system. The concept of biotic potential can be inferred after the pupils are asked to imagine, with the help of prepared charts, what could happen in a population if reproduction continued without any deaths.

Level 4 *Environments*

Concepts and processes emphasized in this unit: environment, environmental factors, biotic, abiotic, range, optimum.

The environment of an organism consists of biotic factors, which include all the other plants and animals living in the same area; it also includes abiotic factors, such as light, temperature, air, water, and soil. The children experiment with both plants and animals to discover the effects of changing various factors, to establish a range of conditions for testing each factor, and to find the optimum part of a range for each organism. On the basis of data collected from these experiments, students build terrariums with suitable environments for the organisms. They discuss and plan a human environment that includes other organisms on which humans depend.

Level 5 *Communities*

Concepts and processes emphasized in this unit: pyramid of numbers, raw materials, reproduction, community, producers, consumers, decomposers, photosynthesis, food transfer, competitors.

In *Communities*, emphasis is placed upon interactions among different populations of organisms, the most important of which concerns food. Students examine the interdependent relationships among plants (as producers), animals (as consumers), and microorganisms (as decomposers). The children investigate the capacity of green plants to produce food. They build terrariums containing plants, crickets, and salamanders, and observe the food-chain relationships. And they observe the results of decomposition after burying dead crickets in moist sand.

Level 6 *Ecosystems*

Concepts and processes emphasized in this unit: ecosystem, water cycle, oxygen-carbon dioxide cycle, pollution, food-mineral cycle.

The cycle concept is introduced by means of experiments with evaporation and condensation of water that lead to an understanding of the water cycle. Students learn that the ecosystem is maintained by the intake of energy from the sun and by the continuous recycling of materials between organisms and the environment that surrounds them. Ecosystems are seen to include all the concepts in the life/earth science sequence as children see the pattern of ecosystems in North America and identify their own ecosystem. Changes in the balance in natural ecosystems, including those caused by pollution, are studied.

Helping Children Learn with SCIIS

SCIIS is a science program based on direct experience. It is intended to affect the ways children think and reason. In addition it is expected to influence how they will reason and make decisions about problems when they become teenagers and adults. Such thinking and decision-making may well determine the individual's responses to a wide variety of personal and societal issues: Should I smoke or not? Should I vote for or against the use of coal as an energy source in my community? In both cases the intelligent person must be able to understand the variables, critically assess advertising campaigns and the statements of special interest groups, and separate emotional appeals from real evidence.

SCIIS fosters this kind of thinking and decision-making, which is quite different from the kind of skill-oriented learning that takes up a large part of the child's elementary school experience.

The need for skill learning. Children need to learn the skill aspects of language, writing, and arithmetic. Your role in teaching these skills is that of an instructor (one who imparts information) who knows precisely what is to be learned and "gets it across" effectively. The importance of such instruction cannot be questioned, because the skills are basic to participation in society.

Development of reasoning. The individual, however, deserves and needs a great deal more than skill learning to participate meaningfully in a democratic society. The ability to use one's own experiences as a foundation for understanding, interpretation, and decision-making in life is essential. It is this ability to observe, collect evidence, analyze, and use the information obtained from one's experiences that is emphasized in the SCIIS program.

For these reasons your role when teaching such experience-based science is that of a helper and fellow-investigator, rather than only that of an authority or imparter of knowledge. The sections that follow describe the components and organization of SCIIS, and how you can use the program to help children learn both science and the approach to decision-making inherent in science.

PROGRAM COMPONENTS

Teacher's Guide. Central to each unit of the SCIIS program is the Teacher's Guide. It shows how the unit is broken into parts and chapters. Specific learning objectives are listed at the beginning of each Part. The rationale underlying the Part is explained under the heading "Background Information." Next is an "Overview" of the chapters that make up the Part. Any suggestions for organizing time and equipment are provided in notes titled "Planning Ahead" and "Getting Ready."

Each chapter begins with a color panel containing a chapter synopsis, the time suggested for covering the chapter, and a list of materials needed for the activities. Major headings within a chapter are "Advance Preparation," "Teaching Suggestions," "Optional Activities," and "Extending Your Experience (EYE) cards." If background information specific to the chapter is needed, it is included just before "Advance Preparation."

At the end of each Part, notices tell you which EYE cards (in the kit) may now be made available to the children and refer you to the appropriate evaluation activity at the back of the Guide.

Following the last chapter of the Guide you will find an "Evaluation" section, a glossary of important terms, and a page explaining design and use of the equipment and materials kit. The life/earth science units also contain an appendix on care of organisms (following the glossary) and an overall schedule of activities.

Scheduling. One activity may extend beyond a single science session, or several activities may be included in one session. The "Suggested time" for working through a chapter is *only* a suggestion; adapt your schedule to allow for special student interest or for greater use of a chapter or activity that is particularly appropriate in your locale.

Teaching suggestions. Under this heading you will find all the activities intended for use by the whole class. Most activities are carried out by individuals or teams working with the necessary materials to collect data or other evidence. While this happens, you are free to move around the classroom to help those who have problems.

Once the data are collected, conduct a discussion of the results, and encourage children to draw conclusions about the data. The work with the equipment and materials and the subsequent discussions are fundamental to the reasoning and decision-making processes SCIIS is designed to foster.

A willingness to improvise and depart from the teaching suggestions will better enable you to meet your pupils' needs. Students may ask questions not anticipated in the Guide or that do not lead in the direction you planned. When this happens, permit the pleasure of a "side trip" by encouraging interested individuals or small groups to investigate independently and report back to the class.

Optional activities. In many chapters individual and small-group needs and interests are met by the "Optional Activities" section. These expand upon topics brought up in the chapter or help in reviewing concepts studied earlier. You may use optional activities to:

- extend the main activities if a child raises a related question
- emphasize one topic for the entire class
- expand the unit extensively if your class is more mature than usual for this level

Optional activities make use of materials provided in the program, common household supplies, or other readily available items. We hope you will include at least a few of these activities in your program, but we do not expect you to use all of them.

Evaluation and feedback. Feedback is information that comes to a person in response to something the person did. As a teacher, you are collecting feedback from your pupils most of the time. An answer to a question yields feedback. So does a child who looks out the window during your demonstration. Informal feedback is an important way to evaluate the progress of your class. In this Guide, we will try to alert you to feedback situations in which children's responses are likely to influence your teaching plans.

In addition to the feedback suggestions included in each chapter, we have prepared an evaluation section that uses a more formal approach to evaluating your students' learning. In general, there is one evaluation activity for each Part of the unit.

Teacher's glossary. Scientific terms and concepts used in the unit are defined in the glossary. The definitions are appropriate for reference during discussions or review and are not intended to be technically exhaustive. We do *not* recommend that you use the glossary to have children memorize formal definitions of terms and concepts.

Equipment and materials kit. Each SCIIS kit includes all necessary materials for the unit except live organisms, common items such as pencils and paper, and perishable items such as batteries.

Each chapter in the Teacher's Guide begins with a list of materials needed and their location in the kit. Starred (*) items in the list are to be provided by the teacher. "Design and Use of the Kit" (page 114) and labels on each kit drawer also indicate placement of items.

Live organisms. The life/earth science units require that you order shipments of live organisms (already paid for), prepare suitable habitats, and allow time for growth and development of the organisms. The life/earth science kits contain the forms for ordering SCIIS organisms. At the back of the Guide, the "SCIIS Plants and Animals" appendix and the "Schedule of Activities" will help you plan and carry out all work with live organisms.

Student manual. The student manual has two major functions: It helps guide the children through their experiences with the equipment and materials, and it provides a place for the individual to record observations, findings, or measurements. During many activities the children record information about experiments in their manuals. This may provide the basis for later discussions.

Encourage children to make entries independently, even though their reports may disagree with those of classmates or with what you consider to be "correct." Some children may change their responses; let them cross out the first entry and add the new one. In this way, their original record is preserved and may be compared with later observations. Records in the manual should be informative, but they need not be perfect.

In addition to organizing the children's work and record-keeping, the manual contains some problems to be solved either individually or in class discussion. But most of the manual is directly related to the children's experiences with the equipment and materials. This relationship makes the SCIIS student manual different from the typical elementary "workbook."

Collect the manuals periodically to review the children's record-keeping and problem-solving abilities. We suggest you refrain from writing in the manuals, either to commend or to correct mistakes. If you find repeated errors in reasoning or data interpretation, arrange for a conference with the child.

Extending Your Experience cards. These cards (two duplicate sets with a display box) are provided primarily to encourage development of individual interests. We have controlled vocabulary on the cards, so that most children should be able to read them unassisted. The illustrations are intended to help the children work independently. Make each card available — by adding it to those in the display box — at the time its use is recommended in the Guide.

The cards may be used in a variety of ways, ranging from totally independent work to a more controlled situation in which you or an aide suggest and supervise a pupil's use of a card.

Some cards may be used for review or remedial purposes. Some may be assigned to provide additional experiences for children new to the SCIIS program. The cards to be used with review chapters at the beginning of the Guide will prove useful for these purposes.

Encourage children to report orally, in writing, or through picture displays after they complete work with a card. They can report to you, to their team, or tivities especially designed to encourage oral and written language development. The addition of Extending Your Experience cards, for example, encourages language development, since the child is asked to describe orally, write about, or prepare a display about the results of the activity.

Mathematics development. The SCIIS program can also do much to encourage children's development of mathematical concepts and processes. Children are urged at all levels to consider the quantitative aspects of their observations and activities. For example, in the *Material Objects* unit (Level 1) the child's concept of number is reinforced by having the child select a specific number of objects as indicated by a numeral card you display. Later, in *Subsystems and Variables* (Level 3) and *Environments* (Level 4) the use of quantitative measurements to produce histograms and graphs is emphasized. Such use of quantitative data provides opportunities for reviewing mathematical concepts, processes, and skills. For many children the introduction to histograms and graphing will be their first experience with these powerful mathematical tools.

Children new to the program. The great appeal of SCIIS derives from its reliance on direct experience, and most children will learn quickly how to participate effectively. However, a few may have difficulty because they lack background or are not accustomed to working independently. You can take several steps to make the transition easier for them.

First, all units after Level 1 begin with a review. By supplementing the review with appropriate activities and EYE cards from previous units, you can help children become familiar with concepts introduced earlier in the program. Use these activities individually or with groups.

Second, you can help a child gain confidence in independent work by showing him or her that there are often a number of alternate acceptable procedures and results in an activity. Encourage the children to find various ways to use pieces of equipment, commend their ideas, and let them share their findings with others.

Environments: An Overview

Organisms, the first life science unit, logically leads to the investigations in *Life Cycles.* The study of populations (in the third-level unit having that name) naturally follows the first two units and flows smoothly into a study of environments, which focuses the children's attention on the surrounding conditions necessary for survival of organisms and populations.

In Part One, after reviewing certain key concepts from previous units, children have a contest in which the winner has grown the tallest plant. Providing optimum conditions for the plants leads to making a list of environmental factors, and that concept is introduced. Children learn to recognize various responses of organisms as indicators of favorable or unfavorable environmental factors.

Children are helped to associate future classroom activities with the environment outdoors by the activities in Part Two. They observe changing climatic conditions and the biological responses to those changes during several field trips to areas near the school. These serve to increase the children's awareness that their classroom experiments are closely related to events outdoors.

Experiments with the effects of light, temperature, water, and chemicals on plants and animals in Parts Three and Four provide opportunities for the children to understand how major environmental factors can influence organisms. Within each activity, the youngsters observe, collect, record, and interpret data from their own organisms and experiments. In this way, the children become intimately involved with and aware of the interactions between organisms and their environments.

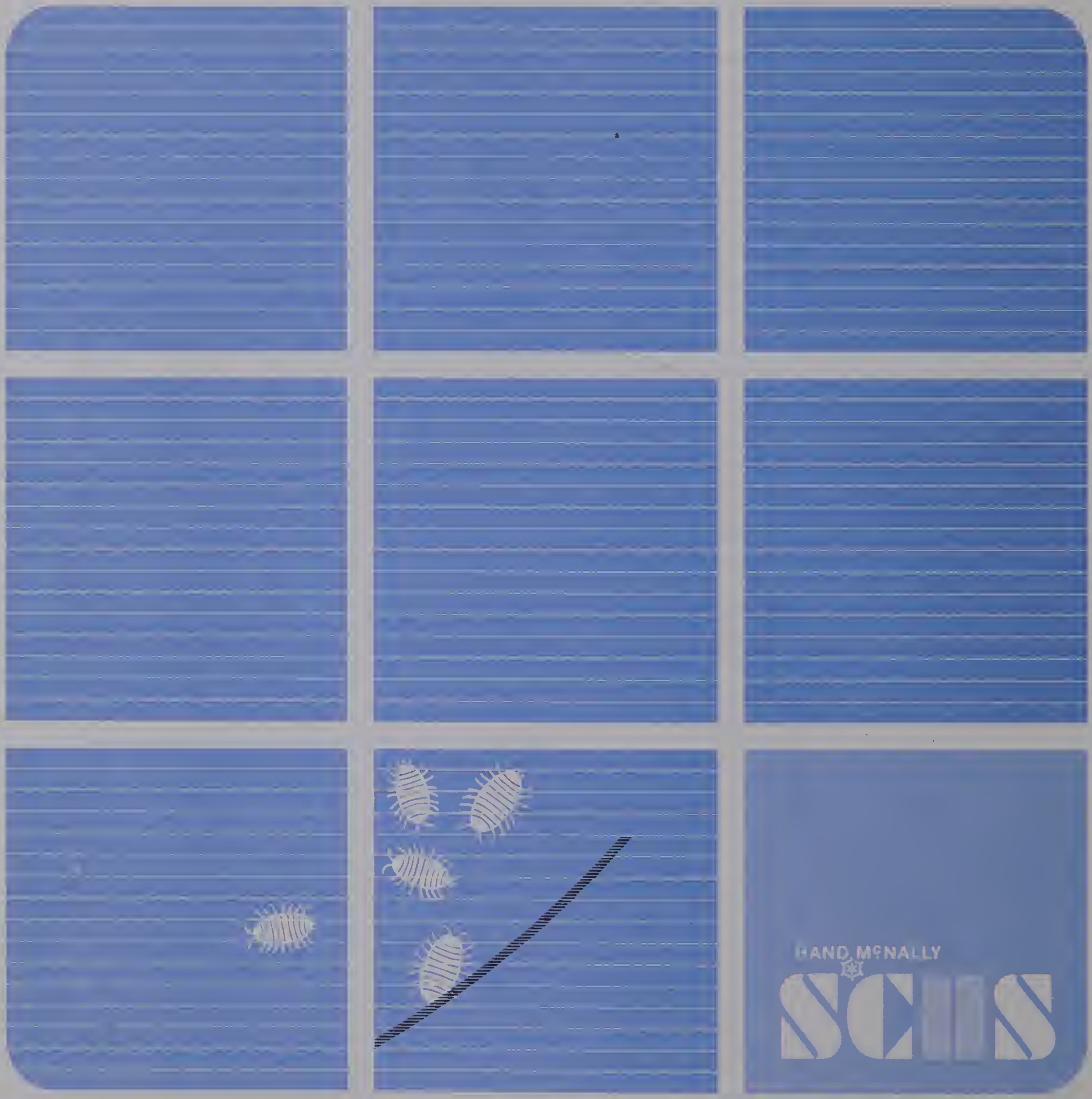
As a culminating activity, the students use their data from previous activities to plan and provide a "perfect" environment for several organisms in Part Five. In applying their new knowledge and experimental data to this practical problem, the children synthesize independent results into a whole picture of the ordinarily unseen events in the biological world outside the school.

Concepts. The following fundamental biological concepts emerge from the activities in this unit:

environment
environmental factors
range
biotic
abiotic
optimum

Other terms introduced, though receiving less emphasis, contribute to the children's understanding. They are: adaptation, response, plant growth, experimental control, and variation.

Part One



Environmental Factors

OBJECTIVES

To analyze an illustration for examples of the concepts *population, plant-animal-eater, predator-prey, food chains* and *webs, barrier,* and *dispersal.*

To plant seeds and to identify and determine the environmental factors responsible for the success and failure of plant development.

To identify environmental factors and distinguish between those that are biotic and those that are abiotic.

To go on a field trip and determine the responses of different organisms to changes in various environmental factors.

BACKGROUND INFORMATION

The term *environment* encompasses all those factors, large and small, that influence organisms. Although the term is now in common usage, it is still poorly understood—people often use it to mean *one set of conditions* surrounding all organisms. Little consideration is given to the fact that each organism requires a different environment, and that an optimal environment for one organism can kill another.

In order to understand the relationship of organisms to their environments, it is helpful to divide any one "environment" into its component parts—parts which we call environmental factors. By thinking of the environmental factors such as light, temperature, moisture, air, and chemicals one at a time, we can visualize the environment better than by trying to comprehend the totality.

For any one environmental factor, there is a range of conditions. Using moisture as an example, we can easily think of two extremes—one in a stream, lake, or ocean, and the other extreme in a desert. And in between, we may have too much moisture for the worms which crawl out of their holes during rainstorms, or too little moisture for plants if there is less rainfall than usual. Any amount of moisture is right for some organisms, wrong for others.

Humans, dogs, or cats would die in the watery environment in which fish thrive. Less obvious examples help us to realize that often there are very fine distinctions between the proper environmental conditions required by such similar animals as field crickets and house crickets. One can wander about in moist grass, but the other will soon die there. One can live on moist food, the other will perish without dry food. Yet they are both crickets. They look and act very much

Figure I–1. Few organisms can tolerate the combination of environmental factors on rocky seacoasts.

Figure I–2. Sandy coasts also are a rigorous environment.

alike although they live best in totally different environments and need different amounts of each of the five major environmental factors.

Environmental factors often have a combined effect, and so it may be impossible to determine the importance of any one factor to an organism's survival by observing the whole environment. In order that your students realize that an environment is composed of many factors, they will carry out investigations designed to determine the effects of isolated factors on an organism.

In Part One, the children first review some of the major concepts from the *Organisms, Life Cycles,* and *Populations* units. They then grow plants in what they think is the correct environment. Using their results, they identify the "things in the environment" that are important to the good growth of those plants. The "things" are identified as environmental factors, and the children then proceed to test the effects on other organisms of changing some of these factors.

OVERVIEW

In Chapter 1, "Review," the children review the populations, plant- and animal-eater, biotic potential, predator-prey, food chain and food web, barrier, and dispersal concepts. In Chapter 2, "The Growth Race," the children plant seeds and grow the tallest plants possible. The concept of environmental factors is invented in Chapter 3, "Environmental Factors," and the children distinguish between biotic and abiotic factors. In Chapter 4, "Responses of Organisms," children look for the result of changing an environmental factor and learn that organisms *respond,* a term which will be used to identify the effects of changing environmental factors.

GETTING READY

You will need a field-trip area near the school for the activities in Chapter 4. See the "Advance Preparation" section of that chapter for help in choosing the site.

Before doing any work in the classroom with living organisms, be sure to read "SCIIS Plants and Animals," pages 108—113.

1 Review

SYNOPSIS

***Children analyze an illustration and review the concepts* population, plant- *and* animal-eater, biotic potential, predator-prey, food chains *and* webs, barrier, *and* dispersal.**

Suggested time: *two class sessions*

TEACHING MATERIALS

For each child:

Drawer 1

student manual page 2

For each team of two children:

Drawer 1

1 small Everglades picture

For the class:

Drawer 1

large Everglades picture

ADVANCE PREPARATION

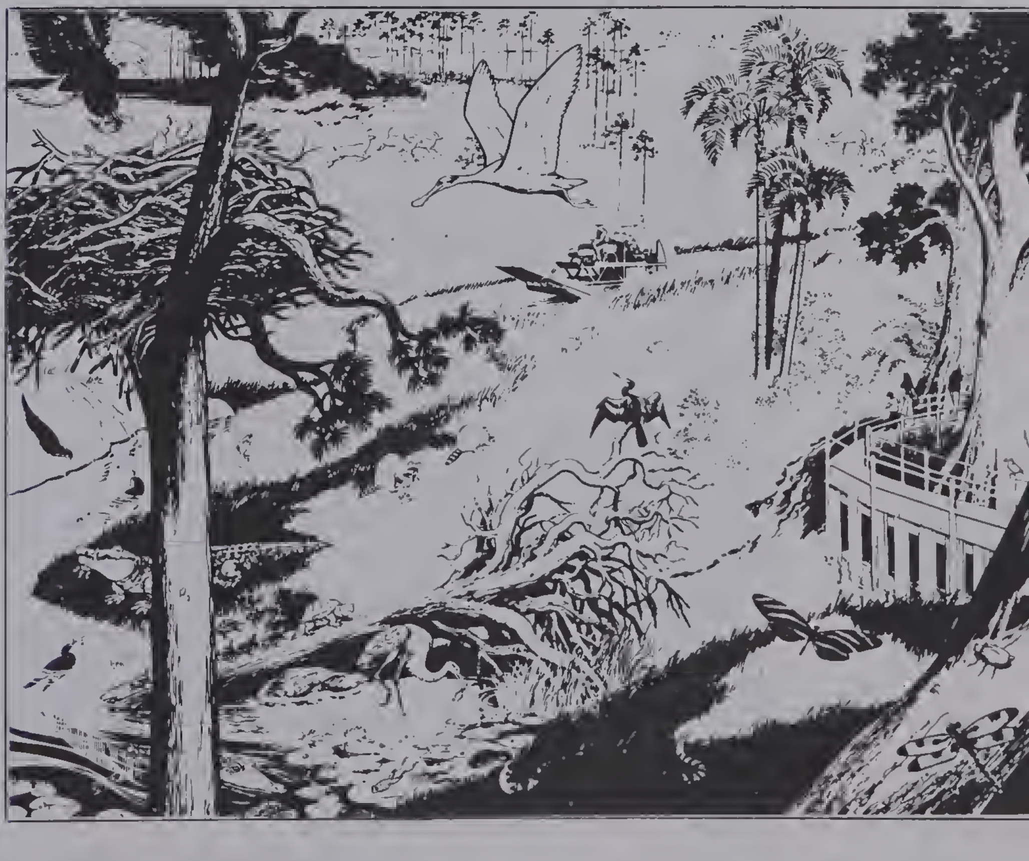
You may wish to read the *Populations* teacher's guide in order to become familiar with some of the activities the children carried out last year and to get some background in some populations concepts that are not repeated in this unit.

TEACHING SUGGESTIONS

This activity is preliminary to any learning cycle concepts but also provides review experiences for the children.

Reviewing *Populations*. Distribute a copy of the small Everglades picture to every team of two children and tape the large picture onto the wall or chalkboard. Let them see the many organisms shown in the picture, and mention that it also shows *populations*—that is, groups of organisms of the same kind living in the same place. (Most of the children who have had the previous life science unit, *Populations,* should have little difficulty distinguishing between populations and individual organisms.)

Figure 1–1. Everglades picture.



- Now ask them to count the number of populations they can find.
- After the children have identified as many different populations as they can, see if the teams agree on the number of populations.

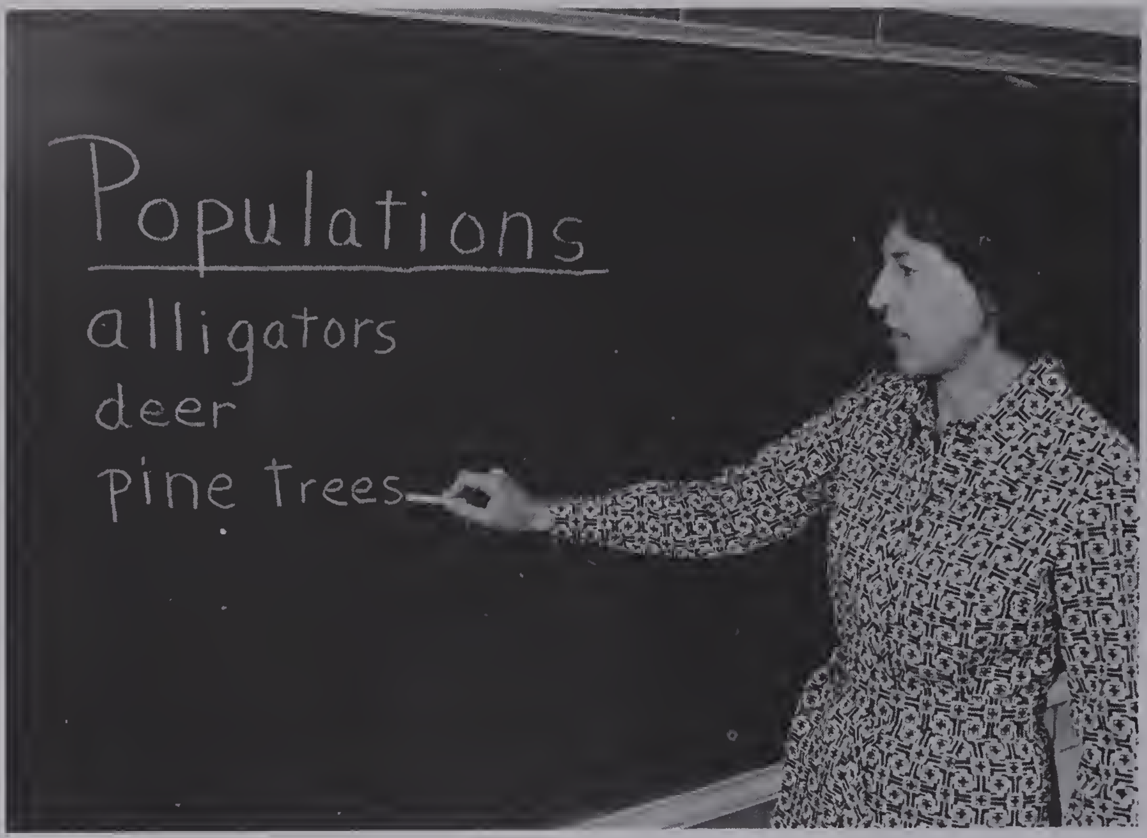


Figure 1-2. Listing some Everglades populations.

- If there is disagreement, ask the team with the largest number to detail the populations from the evidence (the picture).
- Ask the children which populations will probably reproduce. They should name the populations having at least two members.
- After the children have named most of the populations they think will reproduce, ask what they think will happen if most of the organisms reproduce, but do not die.
- If the youngsters don't mention that the populations will increase, review the causes of population increases (more births than deaths, and immigration from other areas).

Plant- and animal-eaters. To review these concepts, divide the class into two groups: one which searches the picture for animal-eaters and the other for plant-eaters. Let the children see which there are more of.

Predator and prey. Review the terms with the children. Predators catch and eat other animals; prey are the animals that are eaten. Ask the children to see how many of each they can find in the Everglades picture. Which animals are they?

Food chain. See if any of the children would like to draw a food chain on the chalkboard, using the plants and animals in the picture. Many food chains are represented, and so there are many opportunities for the children. The teams may draw arrows on their pictures after they have all been reminded of how to draw food chains with the arrows going from the food to the organism that eats it.

Food web. When the children see that two different food chains have one organism in common, review with them how these two chains can be combined to form a food web. Write the two chains on the chalkboard so the common organism of one chain is directly above the other, as in Figure 1-3. Erase one of the two identical words and redraw the arrows so they still show the feeding relationships. This gives a forked effect and represents a food web. Such interconnecting webs, which can be quite large, illustrate the interdependency of organisms (Figure 1-4). Encourage the children to add more organisms to the web you drew as an illustration. If they do not limit their additions to those from the picture, they will be able to make a "giant" web like that in Figure 1-5.

Barriers. Point out the fence below the walkway and remind the children that this is a barrier because it prevents many animals from getting through it. Encourage a discussion of all the different organisms that *can* get past that fence. This brings out the fact that different barriers restrict different organisms, something they probably know already but have not consciously thought about. In this case, small water animals can swim through the fence; insects may crawl over it, and birds will fly over it. But larger animals will be held back. Also ask the children to see how many other barriers they can identify. Ask, "For which organisms are these barriers?" The stream, fire, dry land, and submerged log are some of the more obvious barriers children can identify.

Dispersal. To review the concept of dispersal, you might ask what the children think barriers prevent.

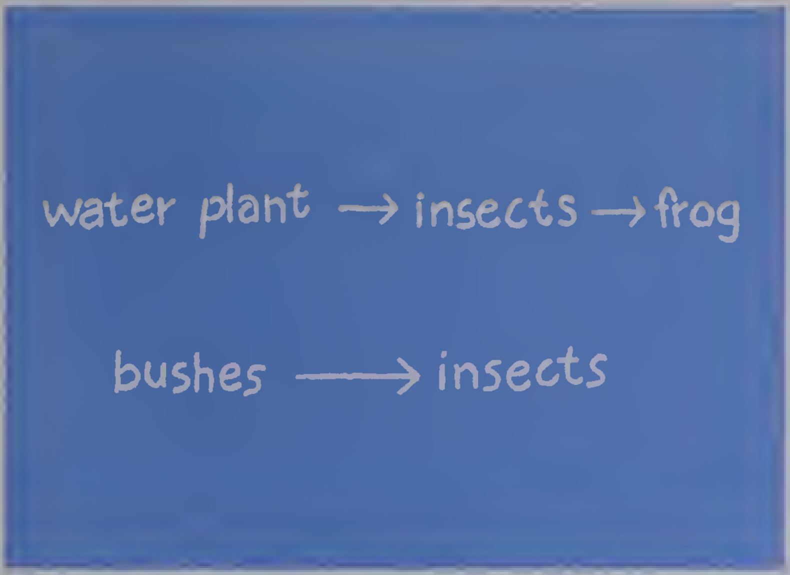


Figure 1–3. Two food chains that may be seen in the Everglades pictures.

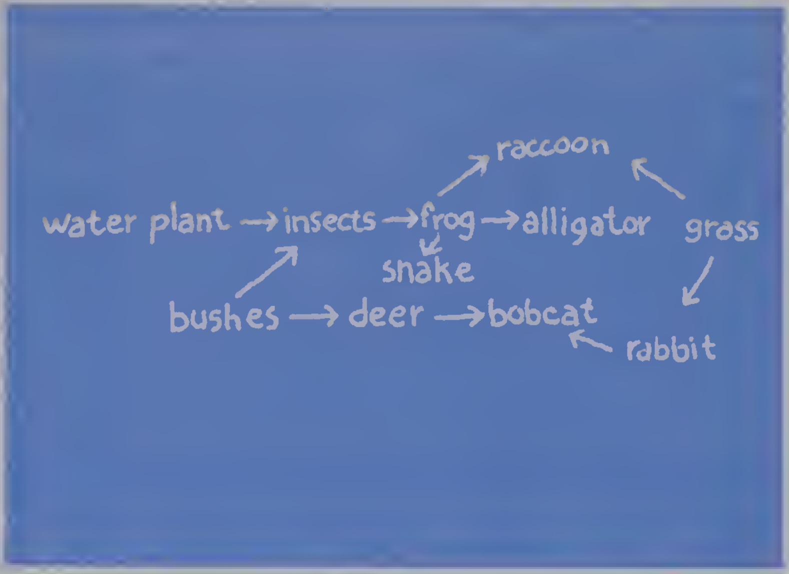
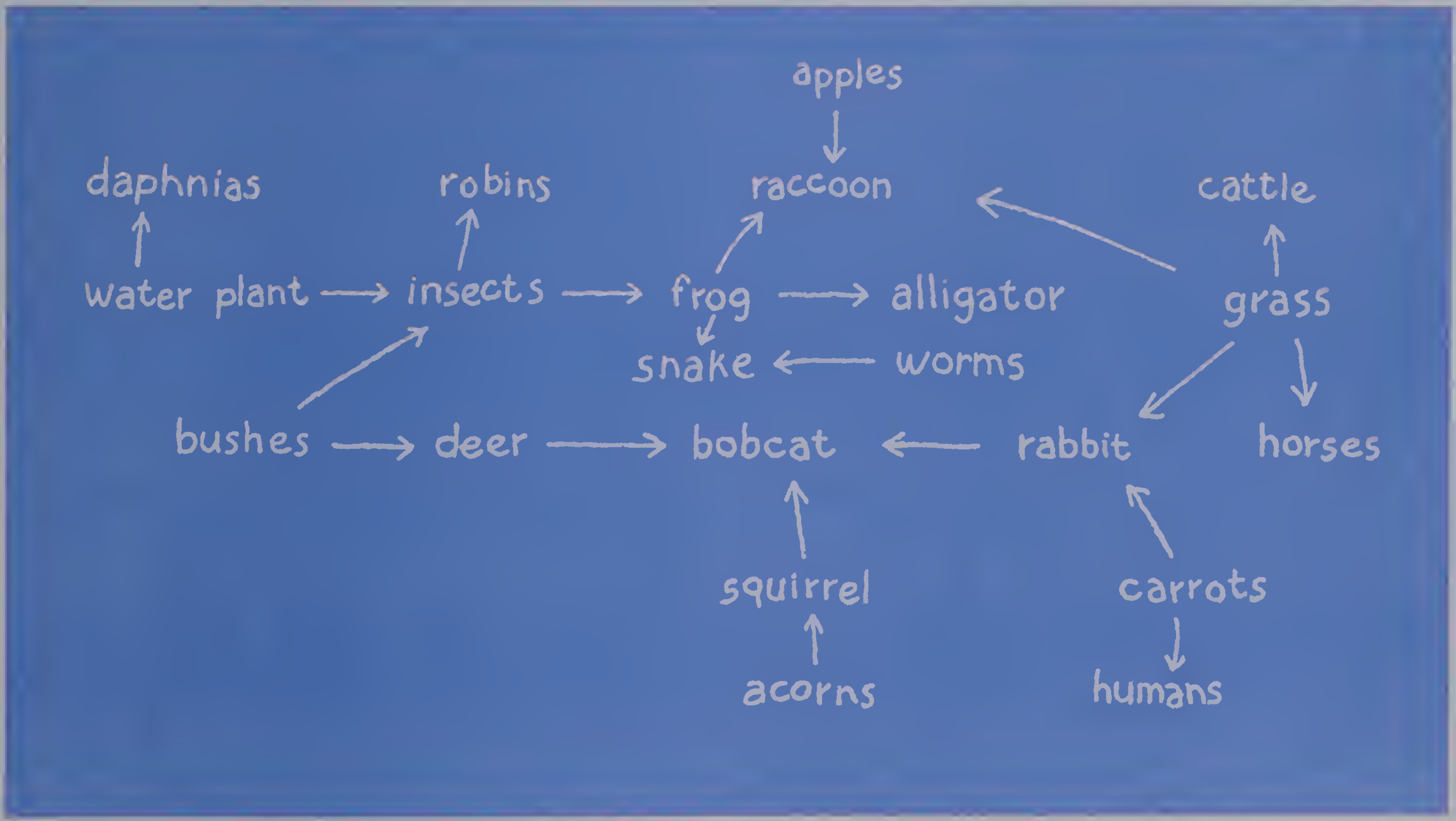


Figure 1–4. Beginning an Everglades food web.

Figure 1–5. Organisms from other areas can be connected to those in the Everglades.

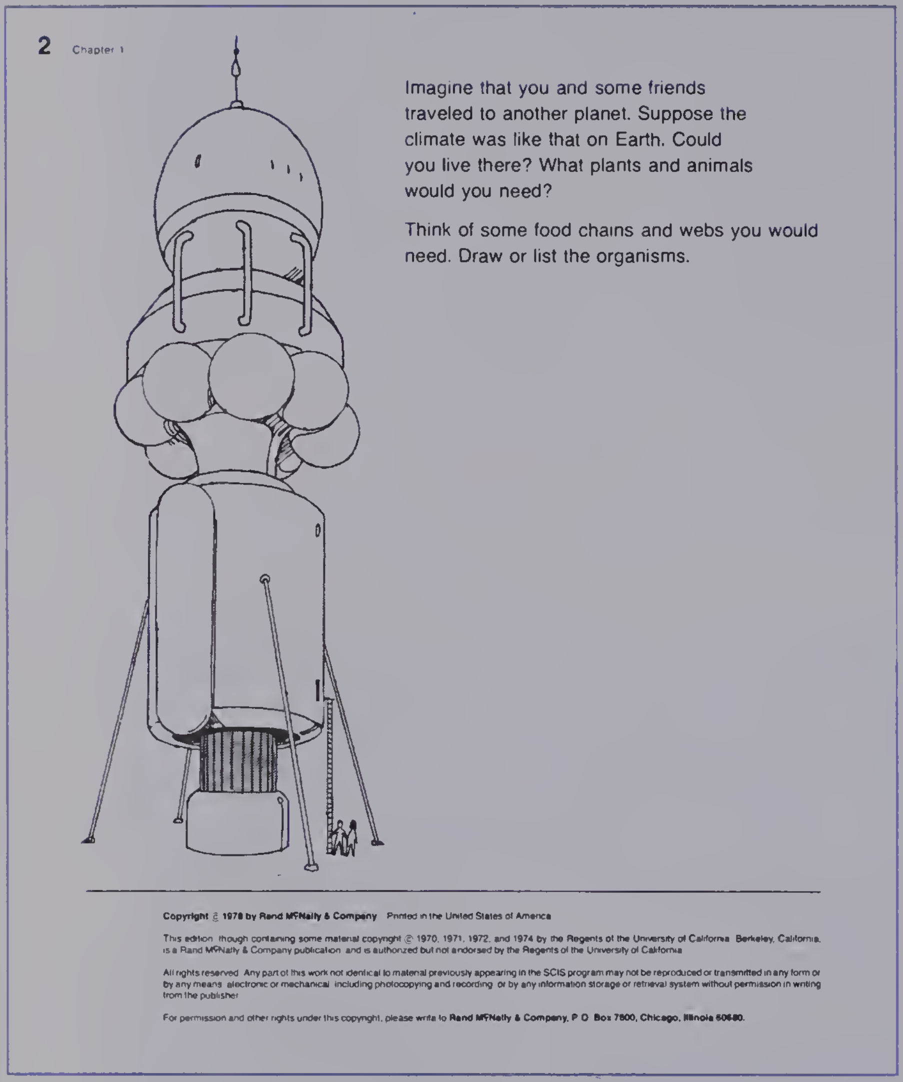


Movement, getting from one place to another, and finding a new place to live may be suggested. Tell them barriers prevent populations of organisms from moving or dispersing. For example, the rabbits probably cannot disperse to the foreground area because of the water barrier. The park ranger in the swamp buggy may become tangled in the lily pads or the submerged log. And the fish will never reach the palm trees on land.

Encourage students to imagine that all the organisms reproduce faster than they died, and ask them to figure out which organisms could disperse (1) anywhere, (2) in two or more directions, or (3) not very far at all.

Using student manual page 2. After completing the review of the *Populations* concepts, discuss the survival problem on this page for a few minutes.

You may need to remind the children to write their names on the manuals.



Imagine that you and some friends traveled to another planet. Suppose the climate was like that on Earth. Could you live there? What plants and animals would you need?

Think of some food chains and webs you would need. Draw or list the organisms.

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OPTIONAL ACTIVITIES

Another populations picture. The children may want to construct a much larger picture or mural illustrating the spreading of populations through dispersal, new habitats, and new food chain and food web relationships. This is especially valuable if most of them are new to the SCIIS program.

2 The Growth Race

SYNOPSIS

Children plant seeds and do everything possible to get their plants to develop and grow more rapidly than the others.

Suggested time: ***Setting up this activity requires two entire class periods, and observing and measuring will take another two weeks.***

TEACHING MATERIALS

For each child:

student manual pages 3 and 4
crayons*

Drawer 5

planter cup
planter base

Drawer 3

twistem
1 or 2 fava bean seeds
ruler
scoop

Drawer 4

planter stick

For the class:

2 growing plants of the same kind*
butcher paper*
felt pen*
soil‡

Drawer 4

4 water sprinklers

Drawer 5

fertilizer

* provided by the teacher
‡ Sand and Soil box

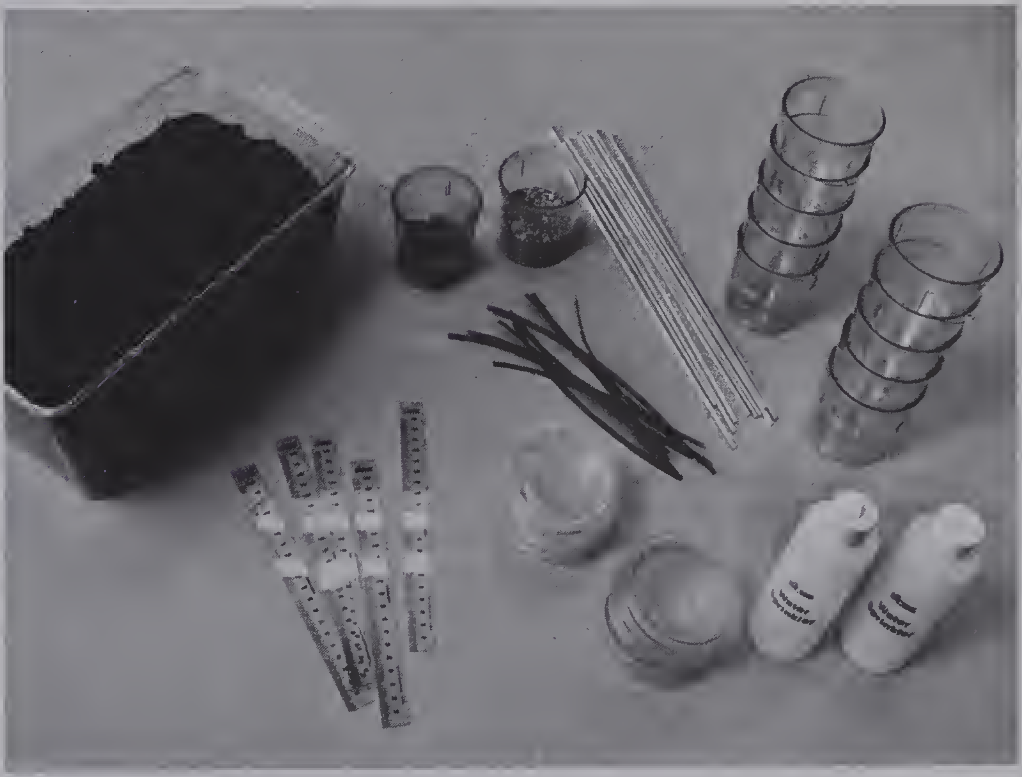
ADVANCE PREPARATION

You will need two plants of the same kind—one short and the other tall—for a demonstration on the day you begin the activity. These can be anything from weeds you pull up on the way to school to prized plants in flowerpots. They will not be damaged.

Prepare two or three distribution stations in order to make it easier for the children to get their materials (Figure 2-1). Place about a third of each item at each of the three stations. In this way, the students can get whatever they need from any one of the stations. (Placing all the cups at one station and all the soil at another does not help matters, because children then have to visit two stations.)

Cut a piece of butcher paper about 1 x 2 meters (about 1 x 2 yards) in size, and hang it on the chalkboard where the children will be able to see it easily.

Figure 2-1. Typical distribution station.



TEACHING SUGGESTIONS

This exploratory activity lays some of the groundwork for the invention of environmental factor that follows in Chapter 3. Later chapters continue a long exploratory phase in the learning cycle that finally leads to invention of environment in Chapter 11.

Asking the question. Begin by showing the tall and short plants you brought to class.

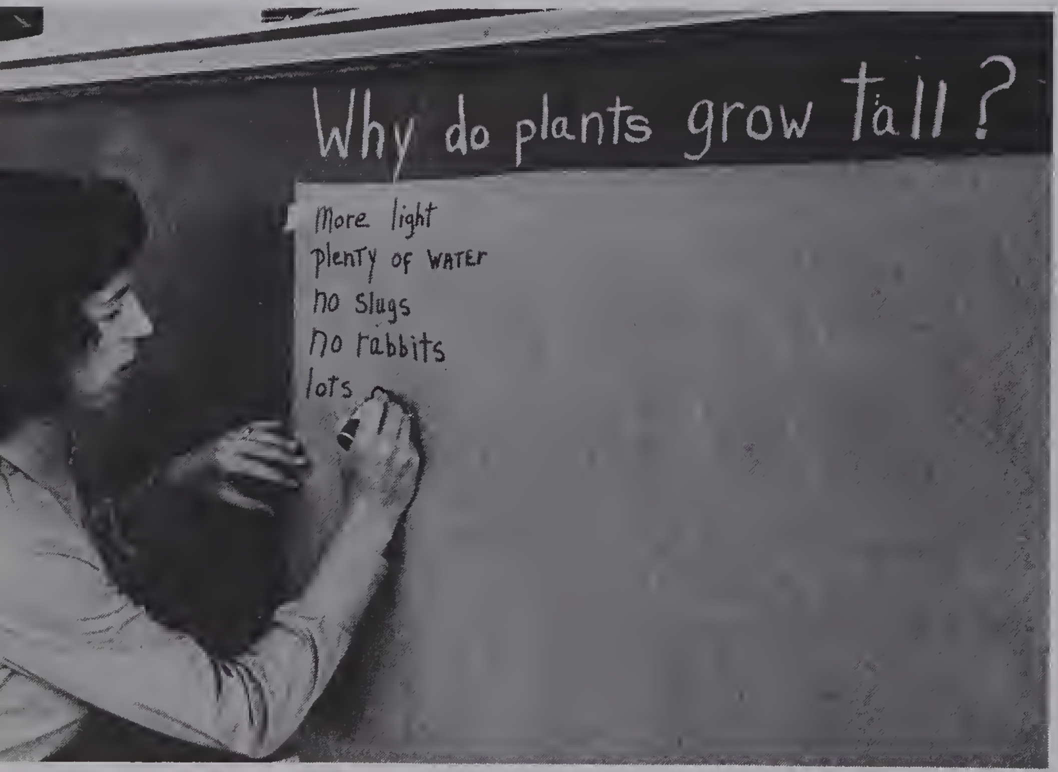
- Using an open-ended questioning technique, ask the children for some of their ideas about what might have caused one plant to grow taller.

- While they are thinking, title the chart with "Why Do Plants Grow Tall?"
- As the students offer their ideas, jot their suggestions on the chart paper. For instance, if a child suggests the tall plant received more light, jot down "more light."
- Try to get as many suggestions as possible.

Our experiences in trial classrooms indicate that in addition to the usual suggestions you would expect (light, heat, water, and soil), children also suggest fertilizers, no wind, love, music, quiet, and other factors, some of which you might not expect. Take all their suggestions and avoid any judgments such as are conveyed by the question, "Are you sure?" or "Is that really important?" We have found that many, if not most, children have not had enough experiences with the effects of environmental factors on plants to be able to distinguish between likely and unlikely influences. Until they have the opportunities to test their ideas, we should not expect precise answers.

Keep the chart posted in the classroom until the end of this chapter, when you will need it again.

Figure 2–2. Writing down the students' suggestions.



Finding out. When no more ideas are suggested, invite the children to plant some fava bean seeds and see who can grow the tallest plants. Everyone will use the same kind of seed, the same soil, and the same type of planter cups. (If you have various types of soils and containers available, use them, but do not ask the children to bring them. The children who can afford special soils and large pots would have an unfair advantage.)

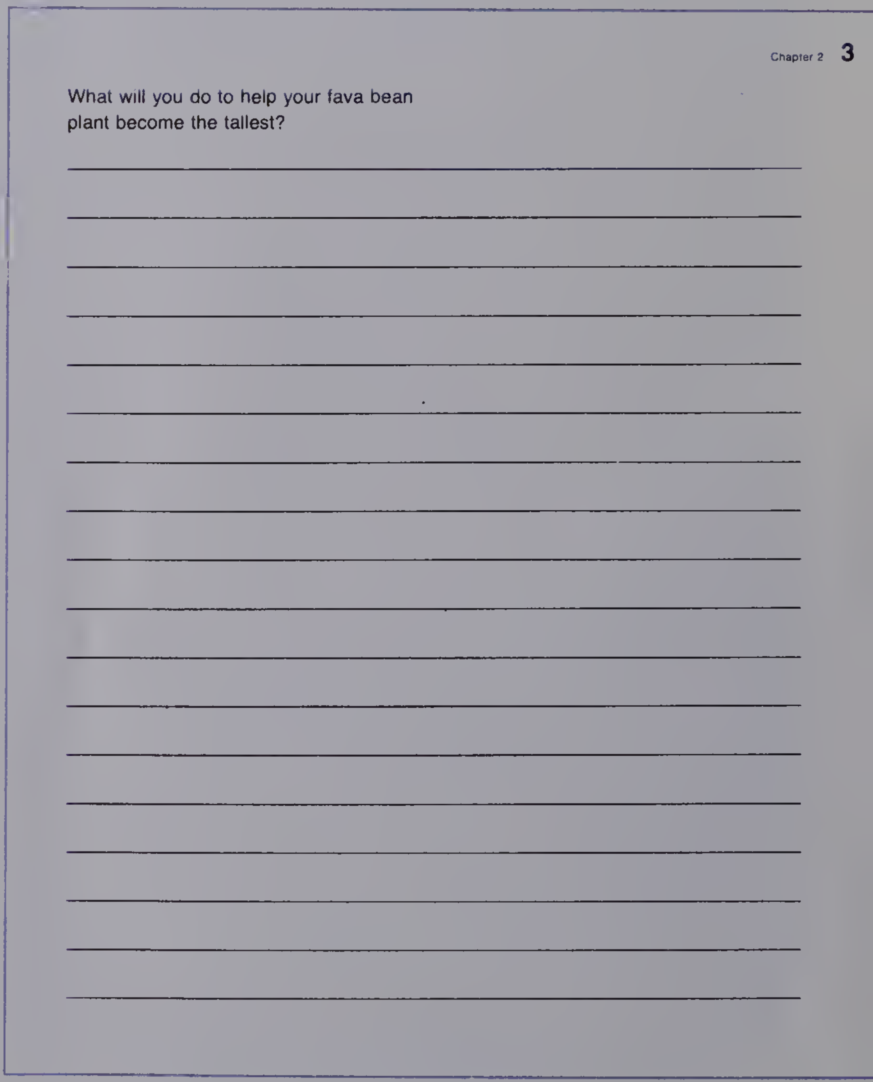
Each child will have one planter and may plant either one or two seeds, whichever he or she thinks will result in one tall plant. Be alert for children who have no idea of how to plant seeds. You will find children who have had a previous SCIIS life science unit will have less trouble.

After planting, the children may vary the amount of water and frequency of application, the fertilizer, the amount of light, the temperature, air currents, type of support for the plants, and any other factors they wish.

Using student manual page 3. Some teachers prefer to have the children prepare written plans of how they will grow the tallest plants. Student manual page 3 provides a place to draw or describe a plan.

The children will have different plans for getting their plants to develop and grow best. Let them water whenever and as much as they think best. Some may want to rotate their plants, add fertilizer, or implement any number of other schemes. You should regulate those schemes which are not in keeping with acceptable classroom rules (such as playing loud rock music twenty-four hours a day).

Beginning the race. Tell the children they can take their time planting the seeds because the race will not really begin until they water the seeds. Let the stu-


Chapter 2 3

What will you do to help your fava bean plant become the tallest?

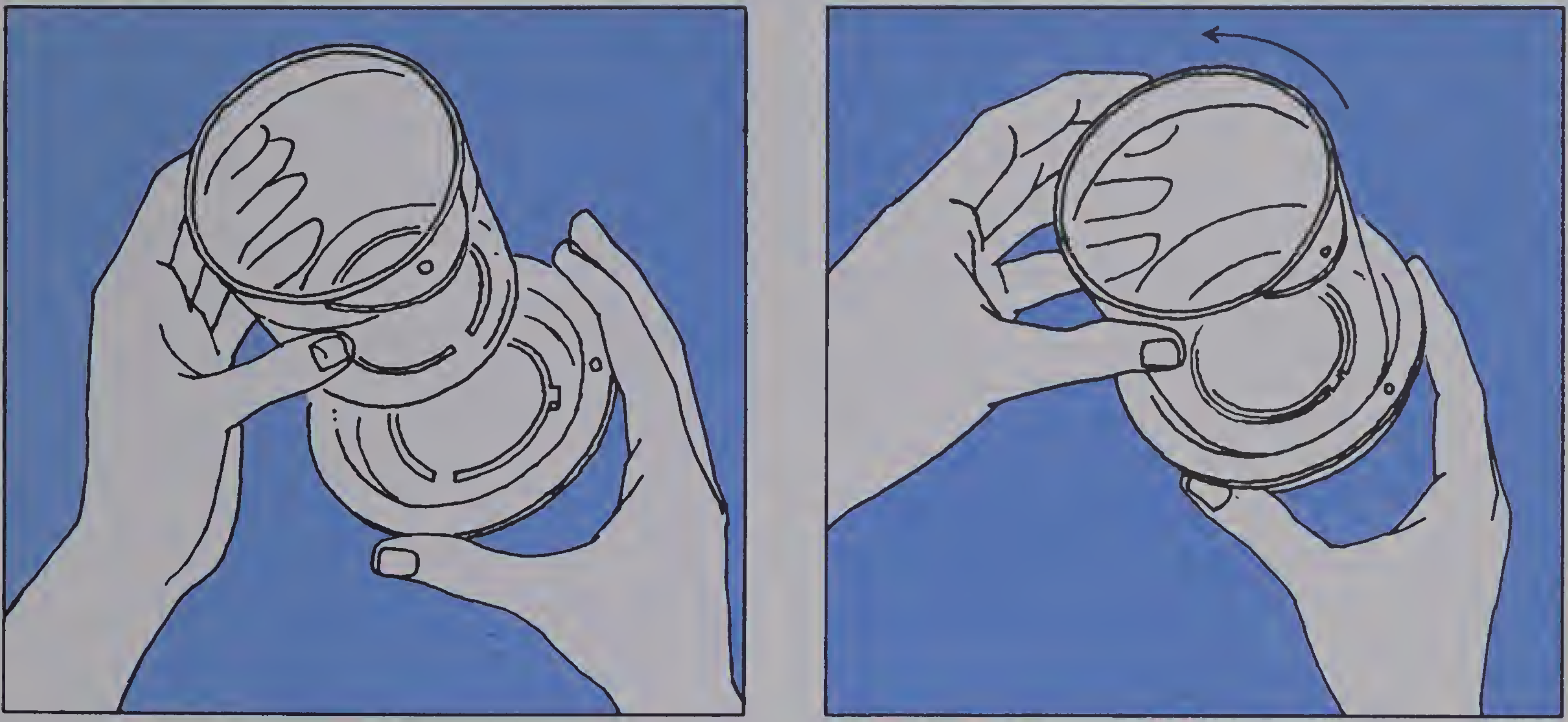


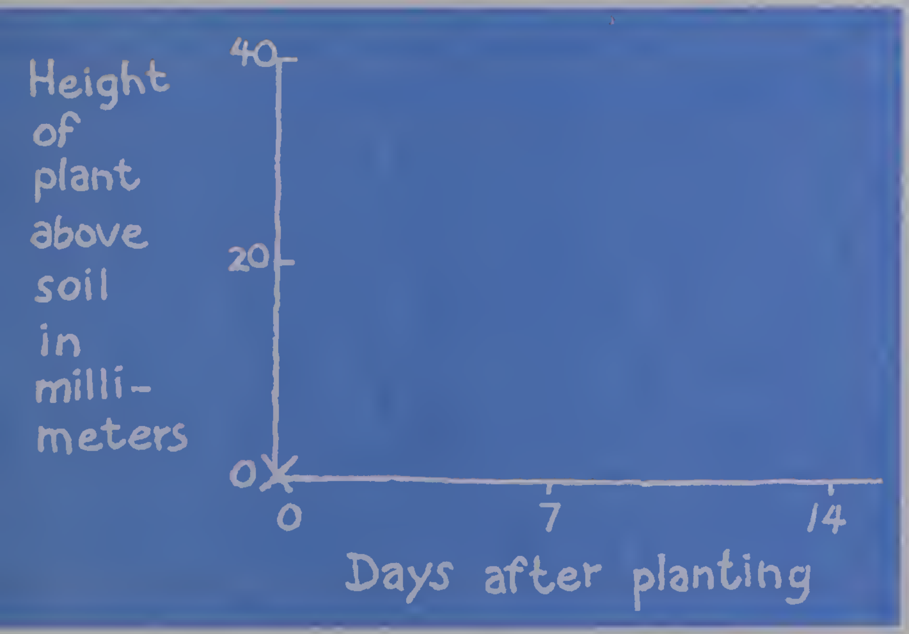
Figure 2-3. Push the planter cup into the base. Turn until you feel the two parts lock together.

dents get their materials and assemble the planters (Figure 2-3). When all the children have completed their preparations and labeled their containers with their names and the date, let them add water.

Storing the planter cups. Each person should be able to store the planter cup where he or she thinks conditions will be best for the developing plant.

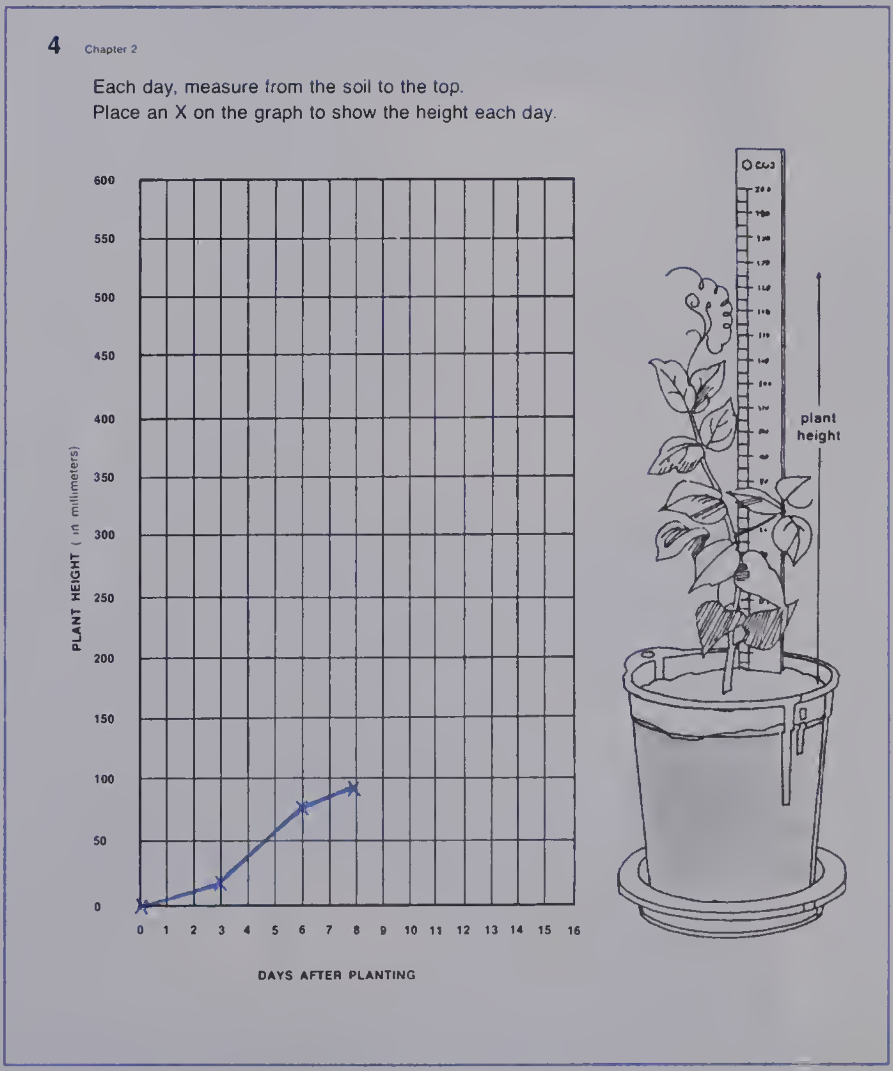
Using student manual page 4. Point out this page to the students and ask them how tall their plants are today. (Height is to be measured only from the soil line to the top of the emerging plant, and so the height of all the plants is zero millimeters today.)

Figure 2-4. Where to place the first X.



Tell the children to put a small X on their graphs at zero days and zero millimeters, where the vertical and horizontal axes of the graph cross. Draw a similar graph on the chalkboard to demonstrate this.

Figure 2-5. One student's plant growth record on student manual page 4.



4 Chapter 2

Each day, measure from the soil to the top.
Place an X on the graph to show the height each day.

Recording and graphing the data. The children are individually responsible for carrying out their plans for watering, fertilizing, and so on, but you should have them measure the plants at the same time. Every other day, or more frequently if you wish, encourage the children to observe and measure the heights of their plants. Each time they measure, they should record the heights. Help those who are uncertain how to graph their data by showing them how to count across to the correct day after planting, then up that line to the height of the plant on that day. The X's should be connected with a line, which is a pictorial representation of the plant's growth (Figure 2-5).

When a few plants have grown to a length of about 60 mm (2–2½ in) show all the children how to push the support stick through the hole in the planter cup rim and into the hole in the base. Form a twistem into a closed shepherd's hook around the plant. Wind the other end of the twistem tightly around the support stick, as in Figure 2-6.

Continue the observations and recording every two or three days. These plants can become very tall, outdistancing the support sticks; stop the contest whenever that happens or about two weeks after planting.

Two weeks after the start of the race, organize the last measurement and final graphing period. Any children who have taken their plants home or grown them elsewhere should return them to school for measurement. Ask the students to transfer the last height measurement to their graphs.

Comparing plant heights. While the students have their graphs in front of them, ask if anyone had a plant taller than 400 millimeters (15¾ in).

If no one answers, continue asking the same question, reducing the height by 10 millimeters each time you ask it. When a student does answer, write his or her name and the plant height on the chalkboard. This student wins the race.

Continue collecting the names of the next four tallest-plant owners and the heights of their plants.

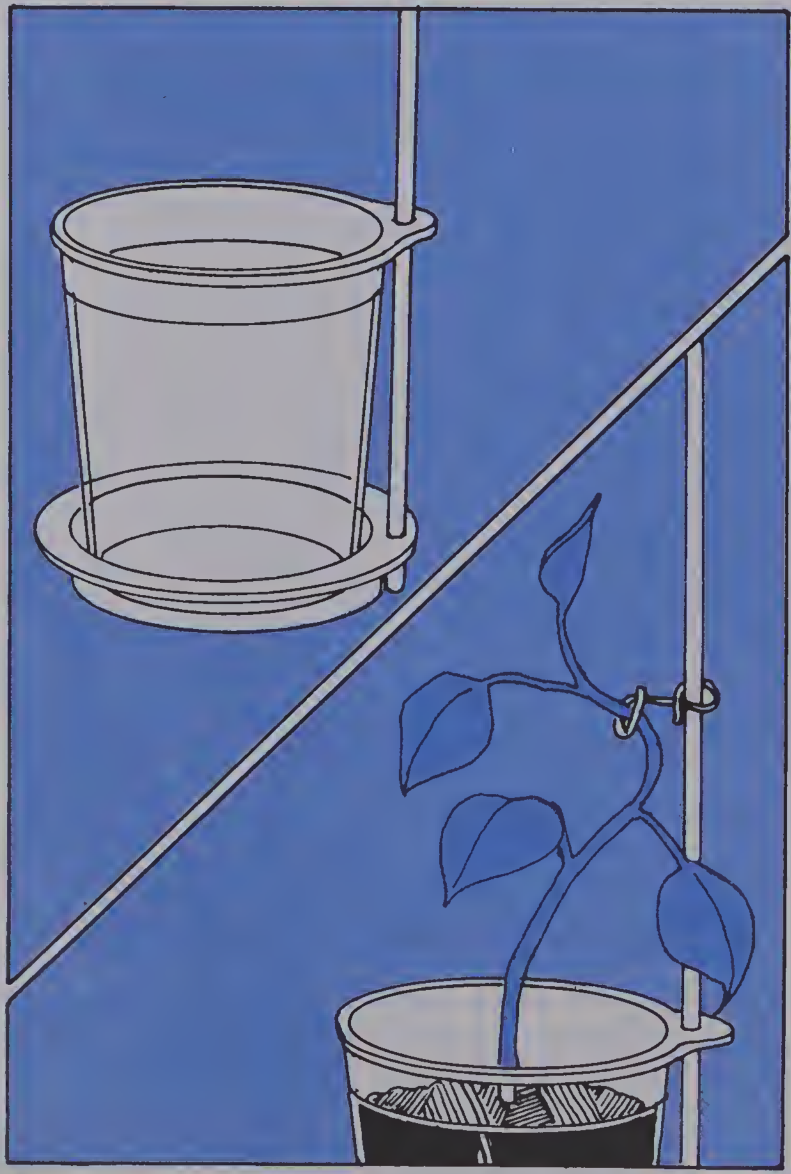
The panel of experts. Form a panel of the five winners and encourage the class to ask questions of the panel members to determine how they were able to grow their plants so tall. The panelists should use their student manual pages as references.

During this discussion, encourage some of the children whose plants either died or did poorly to explain some things they did which may have kept their plants from growing tall.

Using the results of the growth race, go back to the Why Do Plants Grow Tall? chart you prepared and cross out the suggestions that do not appear to have worked. Save the chart for use in Chapter 3.

Cleanup. Save the soil by having the students return it to the soil bags after they have removed the bean plants. The children may take the beans home, plant them around the school grounds, or discard them. Save the wire ties and the sticks. Wash (without detergent or soap) and dry the cups and bases and return them to the kit.

Figure 2-6. The proper way to support a plant.



3 Environmental Factors

SYNOPSIS

Children identify the "do's and don't's" of maintaining plants so they will grow well.

Children translate these "do's and don't's" into environmental factors and subdivide these into two classes: biotic and abiotic environmental factors.

Suggested time: *one short class session*

TEACHING MATERIALS

For each child:

student manual page 5

For the class:

Why Do Plants Grow Tall? chart from Chapter Two

ADVANCE PREPARATION

Post the chart from Chapter 2 at the edge of the chalkboard.

TEACHING SUGGESTIONS

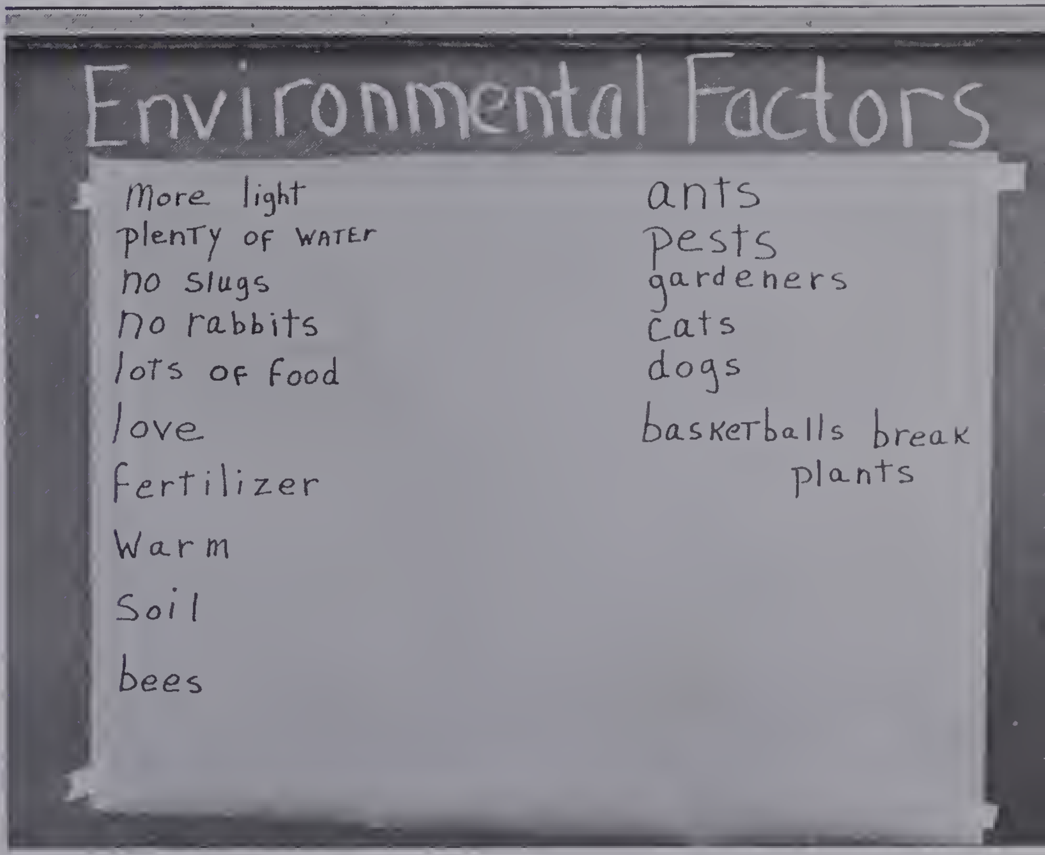
This chapter forms the invention phase of the learning cycle for *environmental factors.*

Referring to the chart, remind the students that in the previous activity, they collected evidence indicating that these things favorably affect the development and growth of plants.

"Inventing" *environmental factor.* Print the term *Environmental Factors* on the chalkboard above the chart, as in Figure 3-1. Tell the students that anything near the plant and that affects it is an environmental factor. Point to the list and tell the children that the items they suggested are environmental factors because each one could affect the way a plant develops or grows.

Environmental factors for animals? To avoid leaving the children with the idea that environmental factors are for plants only, name an animal (dog, cat, rat, bird, fish, rabbit) they are all familiar with and ask, "What do you suppose affects dogs (or other animals)?" After they come up with several environmental factors for the animal you named, tell them that there are environmental factors for animals too, just as there are for plants.

Figure 3–1. Giving environmental factors a name.



Environmental Factors

more light
plenty of water
no slugs
no rabbits
lots of food
love
fertilizer
warm
soil
bees

ants
pests
gardeners
cats
dogs
basketballs break plants

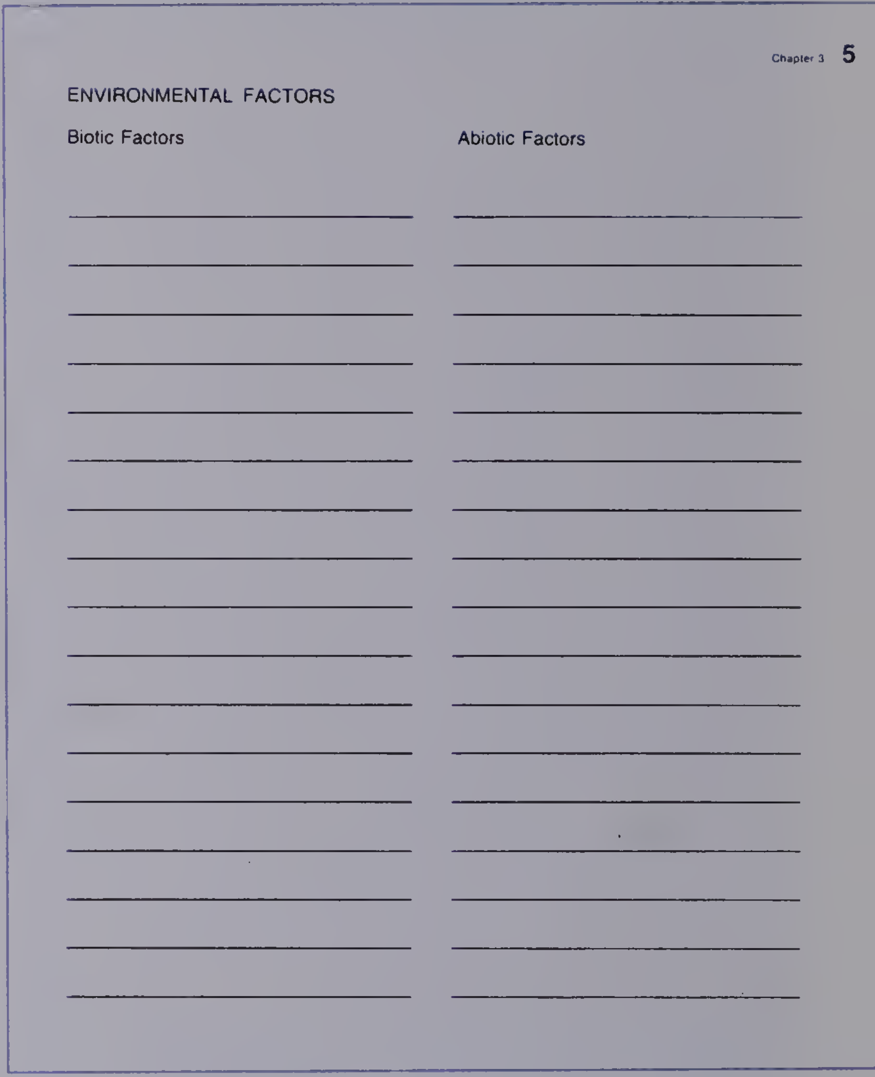
Review. Refine your original definition of environmental factors to include all organisms rather than only plants. This will help review the term *organisms* (all plants and animals) and help the students realize that water (an environmental factor) is important to both animals and plants.

Two kinds of factors. There are two kinds of environmental factors: *biotic* (those environmental factors which come from organisms), and *abiotic* (those environmental factors which do not come from organisms). Examples of biotic factors are: presence of other organisms, noise from other organisms, remains of or from other organisms, and all such factors which arise from other organisms. Examples of abiotic environmental factors are: light, temperature, water, chemicals, space, wind, and other environmental factors which are part of our physical environment and which do not arise from organisms.

Explain to the students that some environmental factors are caused by organisms and some are caused by non-living objects such as buildings, cars, etc. Explain the difference between the two factors and give some examples of each. (Shade can be made by a tree or a building.)

Next to the term Environmental Factors which you have printed on the chalkboard, print "biotic" and "abiotic" (Figure 3-2).

Using student manual page 5. Ask the students to decide which of the environmental factors they named on the chart are biotic factors and which are abiotic, then make two lists in the student manual. Visit each student to see if he or she is having trouble sorting the factors into two sets.

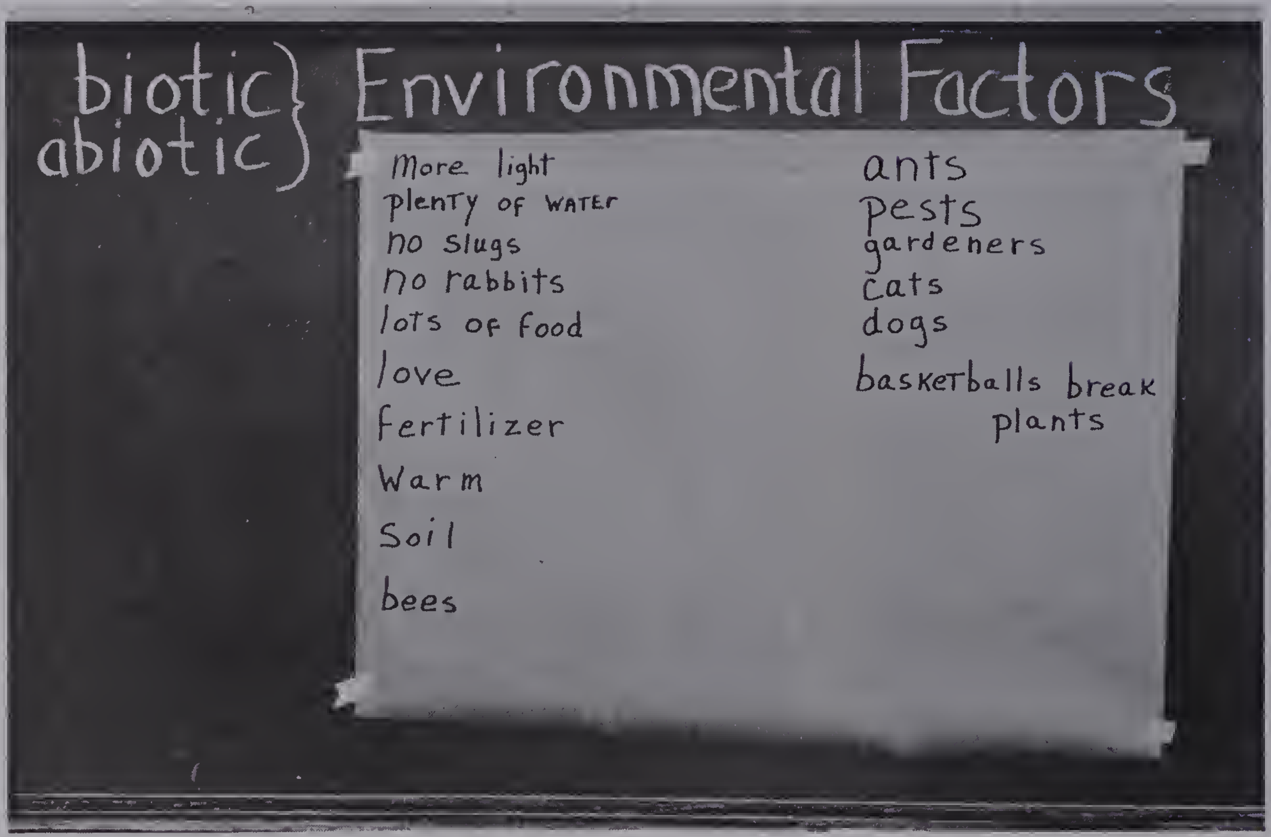


Chapter 3 5

ENVIRONMENTAL FACTORS

Biotic Factors	Abiotic Factors

Figure 3–2. Sorting environmental factors into biotic and abiotic.



biotic} Environmental Factors
abiotic}

More light
plenty of water
no slugs
no rabbits
lots of food
love
fertilizer
Warm
Soil
bees

ants
pests
gardeners
cats
dogs
basketballs break plants

4 Responses of Organisms

SYNOPSIS

Children search a local area to find various plants and animals.

Students test the reactions of various organisms and learn to use the term response.

Children discuss and make inferences about changes in the organisms that may be related to changes in the environment.

Suggested time: ***three to five class periods over a period of two to three months***

TEACHING MATERIALS

For each child:

student manual pages 6 and 7
notebook *
pencil *
paste *

Drawer 4

wooden stick

For the class:

ice cubes (optional) *
assorted items (optional), such as foil, boards, and foods§

Drawer 4

4 water sprinklers
6 thermometers

* provided by the teacher
§ provided by the children

ADVANCE PREPARATION

Select a convenient area—part of a field, a vacant lot, or a section of the school yard—where children can observe organisms in their natural habitat, not in a special park or zoo. Look for an area in the vicinity of the school because you will revisit it frequently. It should be at least 15 x 15 meters (50 x 50 ft) in size.

The area you select should have as wide a variety of plants and animals as possible, but a site with as few as three different kinds of small animals and five different kinds of plants is satisfactory. Most schools have many times those numbers of organisms within their boundaries. An area from which deciduous trees (trees that lose their leaves in winter) can be seen is very desirable.

You might want to combine this activity with the sort of playground mapping carried out in Chapter 16 of *Relative Position and Motion*. If so, follow the instructions there.

TEACHING SUGGESTIONS

This chapter begins the discovery phase of the learning cycle for *environmental factors*. The concept of *response* is "invented."

A day before the field trip, explain to the children that they will be taking a field trip tomorrow to whatever area you have selected to look for organisms.

- Remind them that organisms are all animals and plants.
- Also tell the children that not only will they look for organisms, but each child will change an en-

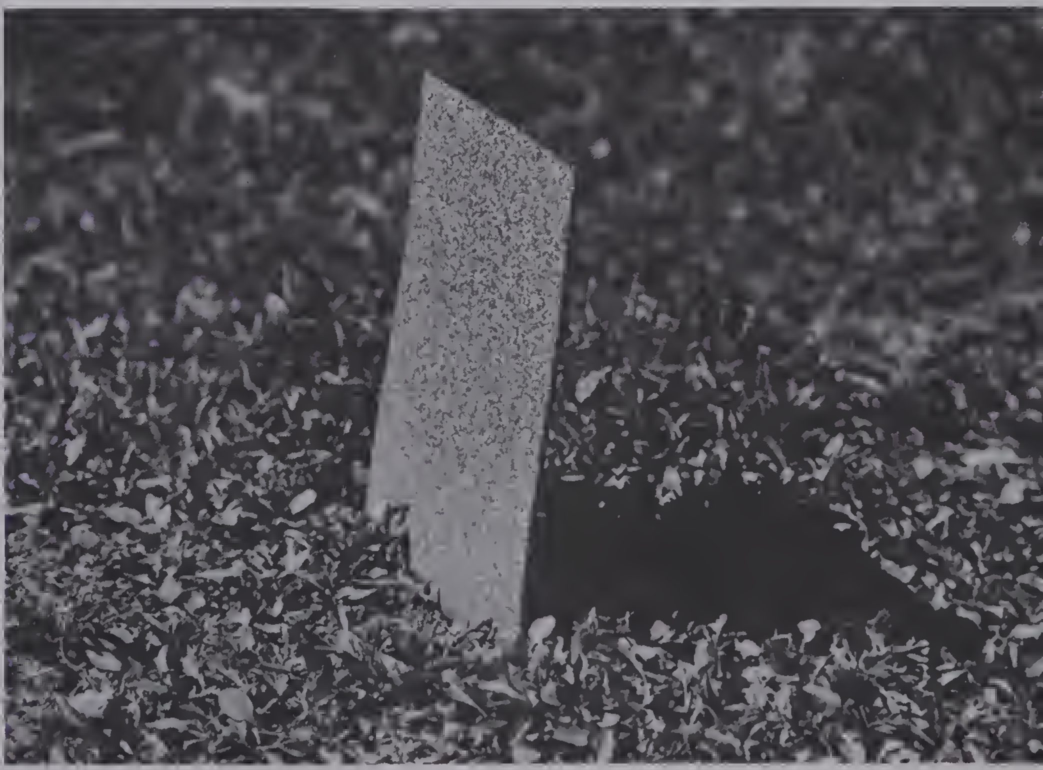
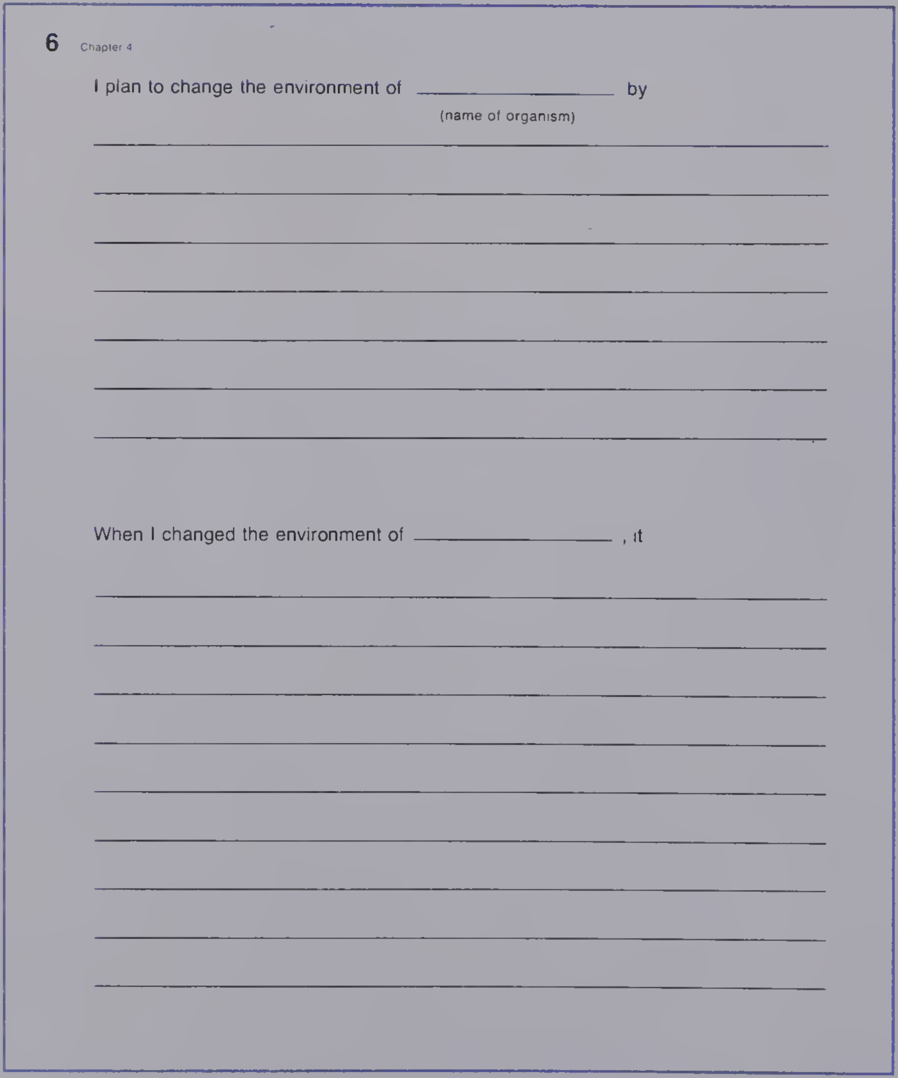


Figure 4–1. Changing the environment.

vironmental factor for one of those organisms.

- Have them think about which organisms they might work with and solicit ideas as to which environmental factors they could reasonably change during the time they are outdoors.
- Some ideas which have come from other groups of children this age are: "We could make it colder with an ice cube"; "Make it rain with a sprinkler"; "Take them (small animals) some food"; "Water a dying plant"; "See what they do with different smells." Some other ideas are: shelter a bird nest, put a paper lunch bag over a small weed, support a wavering plant, water the soil in a dry area where some seeds may have blown, block the light falling on a small patch of weeds, put various leftover food samples near ants or other small animals, turn over a rock with animals under it.
- You might consider a short preliminary trip to the site today.
- On the field-trip day, each child should be responsible for bringing what he or she needs (with the exception of ice cubes, which you may be able to provide from a school refrigerator).



6 Chapter 4

I plan to change the environment of ______________ by
(name of organism)

When I changed the environment of ______________ , it

Using student manual page 6 *(top).* Encourage the children to use the top half of this page to show by illustration or words which organisms they have chosen and how they will change the environments.

Explain to the students that the bottom of the page will be used later for describing or showing what happened after they changed the environmental factor.

The field trip. On the day you take the children to change the environments of the organisms, check to see if they have completed their plans and have their materials ready.

While on the field trip, visit all the youngsters to see how they are doing. If a boy is setting out food, encourage him to mark the spot, perhaps even draw a small map. If a girl is trying to cool a hot plant with ice cubes, inquire how she will keep it cool for a week in order to find out if the plant changes. The child trying to attract ants with his salami may not know that the ants probably can't find the food when it is placed 6 meters (20 ft) away. Encourage placing several pieces closer to the ant trail. You can be of great help to the children by asking easy questions which may help them rethink what they are doing.

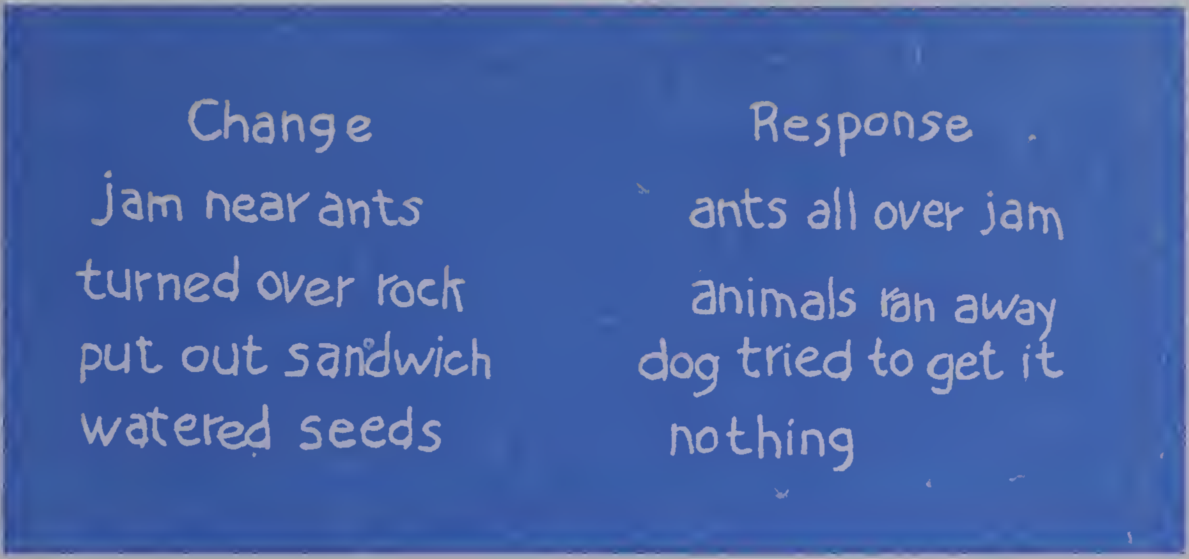
Using student manual page 6 *(bottom).* Back in the classroom, have each child finish the sentence indicating the effect of changing an environmental factor for one organism.

Discussion. Next allow some time for the students to tell each other what happened. As the children explain the results of their efforts to change the environment, use the chalkboard to record at least five of the results. A rather cryptic notation, as in Figure 4-2, is satisfactory.

After you have noted several of the actions and the results, print the word CHANGE in bold letters above the column of actions. Tell the youngsters that when an environment of an organism changes or is changed, there is usually a RESPONSE by the organism. Encourage the pupils to reveal and elaborate on other environmental changes and organisms' responses they have seen, either on the field trip or any time. Whenever possible, try to get the children to use the terms "change" and "response."

Some children may have planned environmental changes which may require a longer time to show a response. Perhaps a return trip to the area on another day will be necessary for them to see evidence of a response.

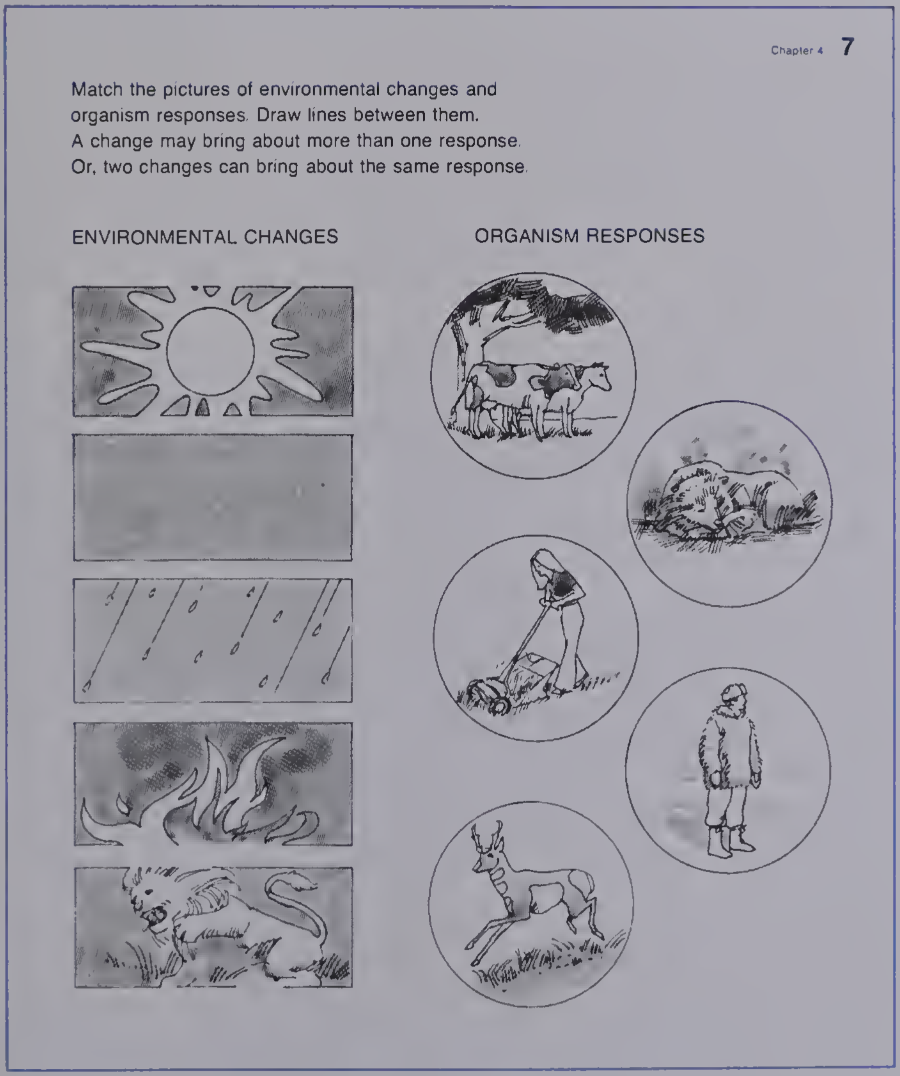
Using student manual page 7. There are many illustrations on this page. Some show environmental changes, others show responses. Suggest to the children that they match the environmental changes on the left to the responses on the right by drawing pen-



Change	Response
jam near ants	ants all over jam
turned over rock	animals ran away
put out sandwich	dog tried to get it
watered seeds	nothing

Figure 4-2. Labeling the two columns.

cil lines connecting the changes to the responses. There are several different correct answers, depending upon what experiences the children have had, heard about, or think can happen. Encourage discussion of the various possibilities.



Chapter 4 7

Match the pictures of environmental changes and organism responses. Draw lines between them.
A change may bring about more than one response.
Or, two changes can bring about the same response.

ENVIRONMENTAL CHANGES

ORGANISM RESPONSES

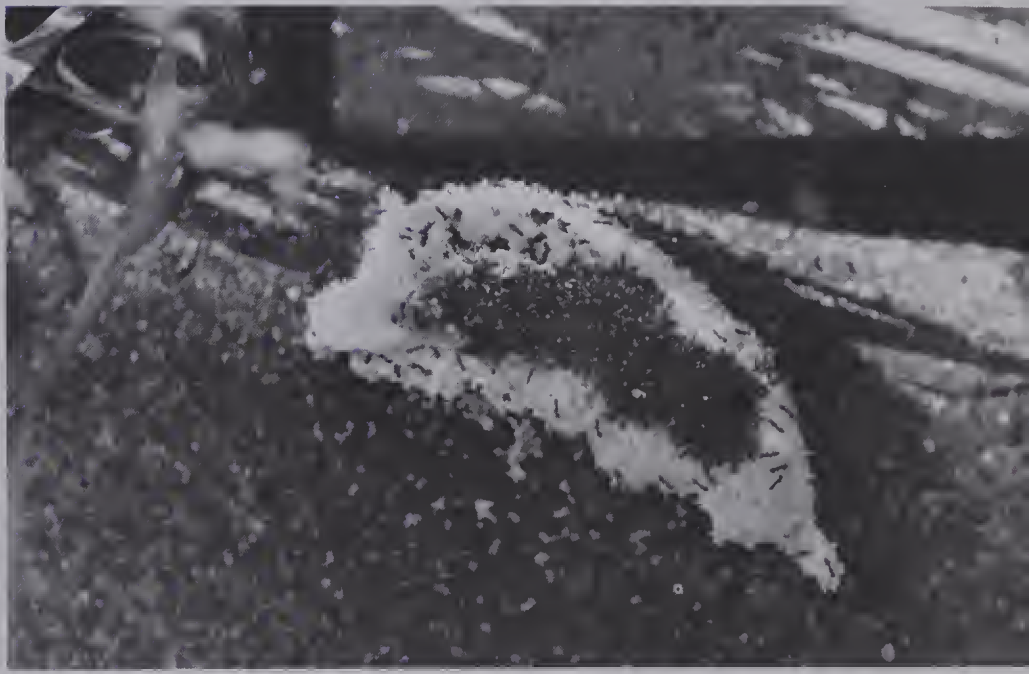


Figure 4-3. Ants responding to an environmental change.

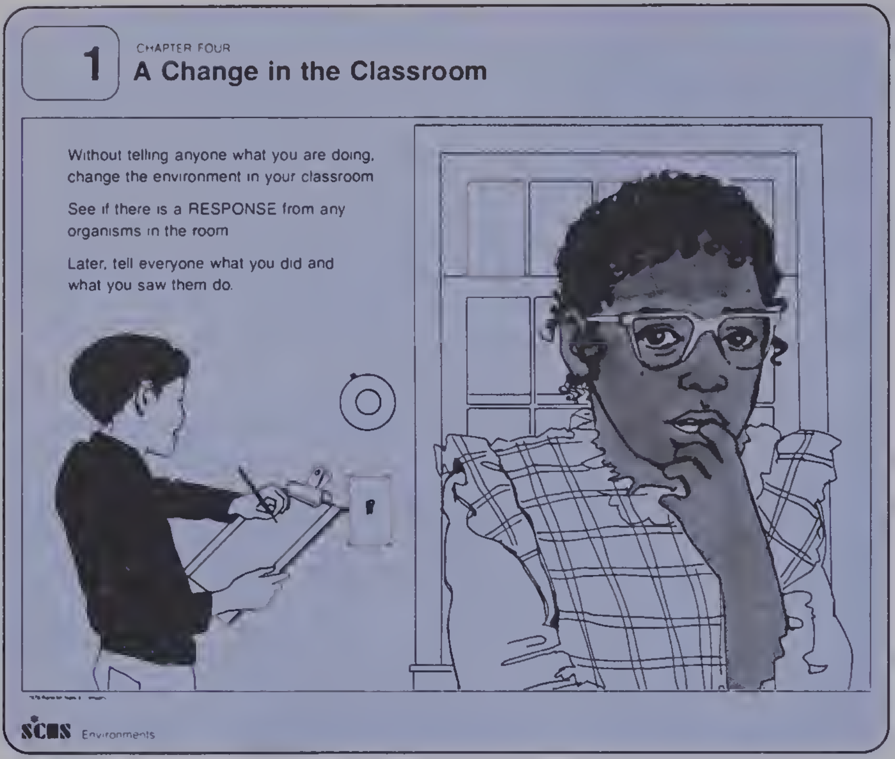
OPTIONAL ACTIVITY

Favorable changes. Simple environmental projects such as shading some oversunned grass; watering a "volunteer" tree or bush; feeding an ant colony, birds, or squirrels; or building a small windbreak for a windbeaten plant can be undertaken by individuals or teams of interested students. In order to reinforce the concepts from this chapter, encourage the youngsters to select projects which involve what they think will be favorable *changes* in the environment yielding *responses* by organisms.

EXTENDING YOUR EXPERIENCE CARDS

Suggestions for using these cards are given on page xvii of this guide.

1. A Change in the Classroom. Any children doing this activity will need your cooperation and suggestions. They might change the classroom environment by raising or lowering the window shades, adjusting the thermostat, turning on a fan, setting out punch and cookies, and so on.


1
CHAPTER FOUR
A Change in the Classroom

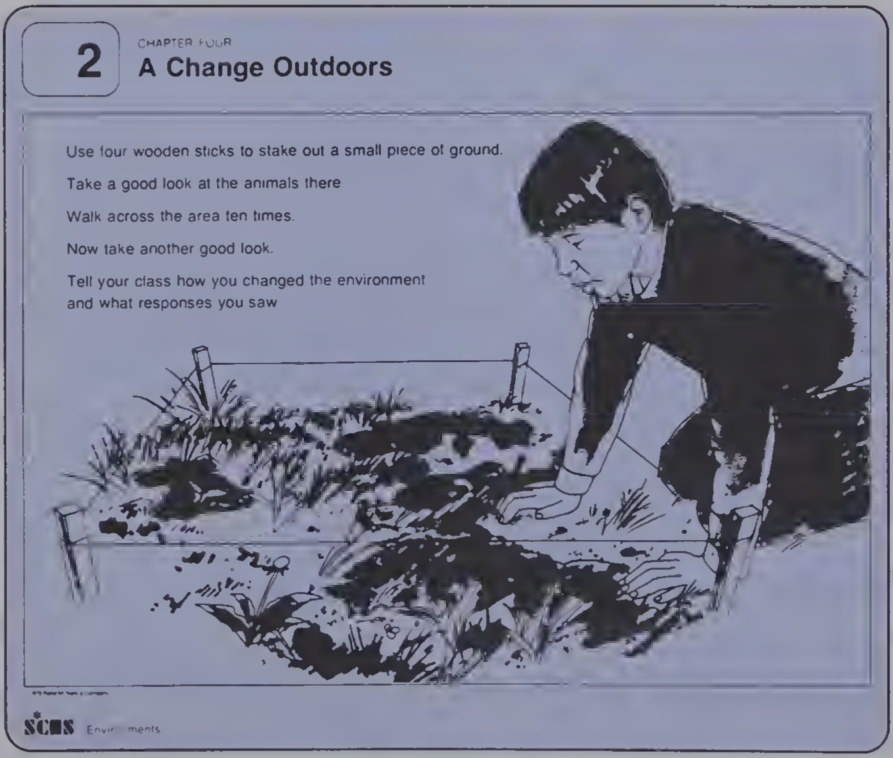
Without telling anyone what you are doing, change the environment in your classroom

See if there is a RESPONSE from any organisms in the room

Later, tell everyone what you did and what you saw them do.

SCIS Environments

2. A Change Outdoors. The child will change the staked-out environment by walking through it, and the animals there will respond, in some way. They may hide, move out of the area, or be adversely affected because of the loss of plants they use for protection or food.


2
CHAPTER FOUR
A Change Outdoors

Use four wooden sticks to stake out a small piece of ground.

Take a good look at the animals there

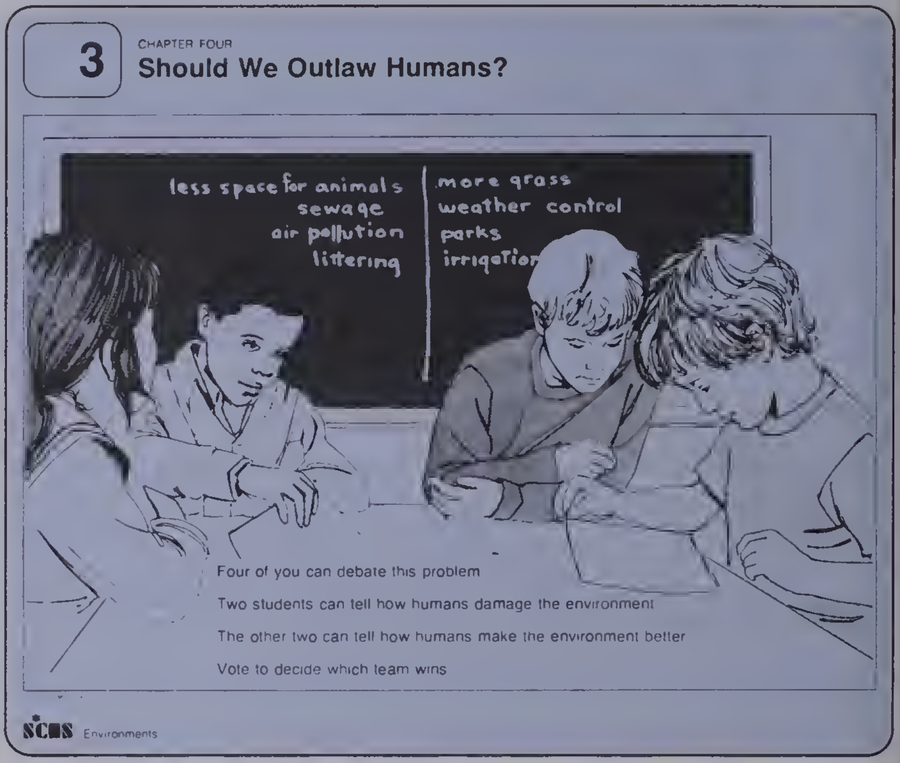
Walk across the area ten times.

Now take another good look.

Tell your class how you changed the environment and what responses you saw

SCIS Environments

3. Should We Outlaw Humans? At least two, and possibly several, students can use this card together. Encourage the students to point out how other organisms might respond when humans change the environment.


less space for animals
sewage
air pollution
littering
more grass
weather control
parks
irrigatio
3
CHAPTER FOUR
Should We Outlaw Humans?

Four of you can debate this problem

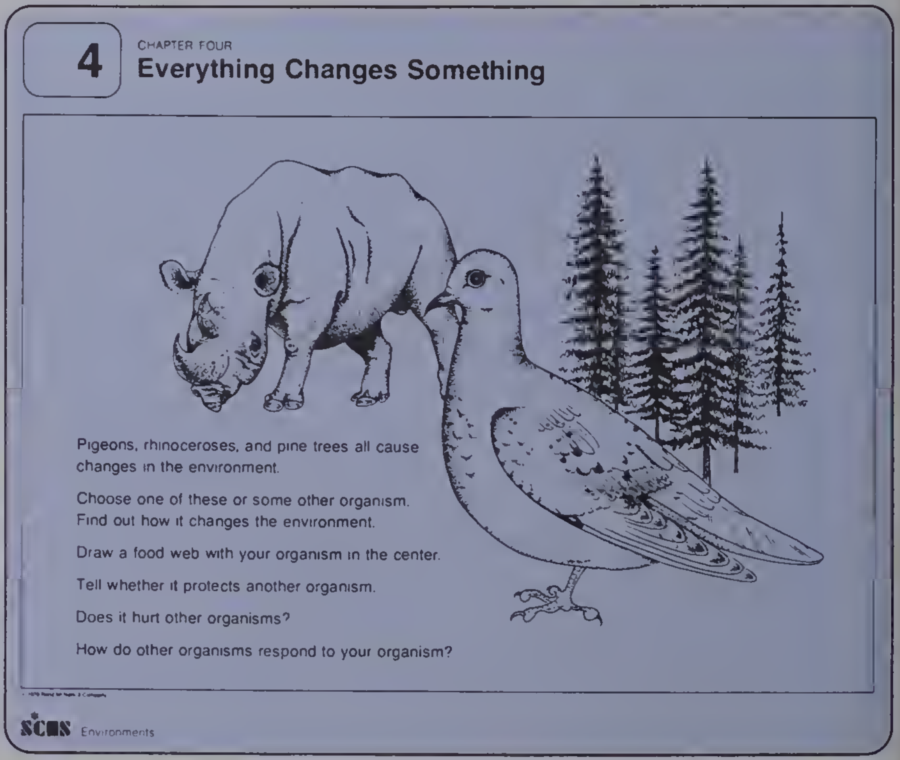
Two students can tell how humans damage the environment

The other two can tell how humans make the environment better

Vote to decide which team wins

SCIS Environments

4. Everything Changes Something. If several children do this activity, try to have each child choose a different organism. If carried to its logical conclusion, this activity would result in the concept that every organism is connected, however distantly, to every other organism. The child should at least realize that each organism contributes to the environment of other organisms.


4
CHAPTER FOUR
Everything Changes Something

Pigeons, rhinoceroses, and pine trees all cause changes in the environment.

Choose one of these or some other organism. Find out how it changes the environment.

Draw a food web with your organism in the center.

Tell whether it protects another organism.

Does it hurt other organisms?

How do other organisms respond to your organism?

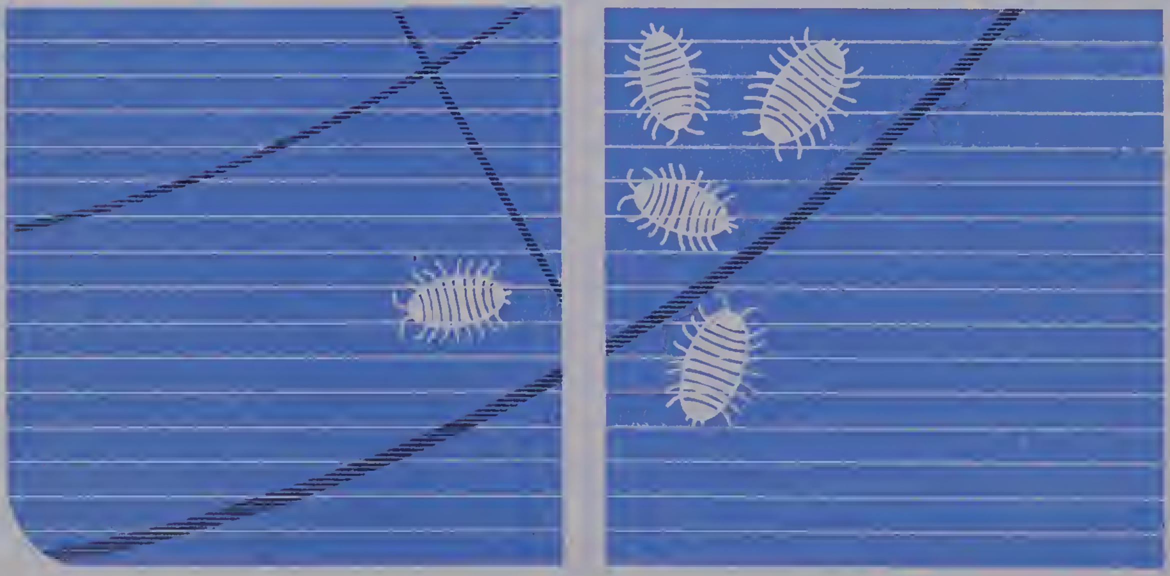
SCIS Environments

Extending Your Experience cards 1–4 are now available for the children's use. For materials needed, refer to the equipment list accompanying the set of cards.

CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's understanding of environmental factors, turn to page 96 of the evaluation section at the back of the guide.

Part Two



RAND McNALLY

SCIIS

Changes Outdoors

OBJECTIVES

To determine the responses of various organisms found in the local environment.

To describe seasonal changes in organisms and their environments.

To hypothesize relationships between changes in organisms and changes in their environment.

To systematically observe, record, analyze, and interpret data from an experiment.

BACKGROUND INFORMATION

All over the world, environments change with the seasons. As fall becomes winter in temperate zones, temperature drops, precipitation increases, and the amount of sunlight decreases. With the coming of spring the reverse occurs. Each year the environment oscillates between the extreme conditions of summer and those of winter. Animals and plants respond to seasonal changes in the environment. In the Northern Hemisphere, some birds fly south in the fall and north in the spring. Deciduous trees lose their leaves in the fall and grow new ones in the spring. The soil warms in the springtime; seeds produced the preceding year germinate and grow into new plants; and during the same time, many animals mate and produce their young. The responses of each organism to these environmental changes vary considerably.

In order to introduce the children to the many responses of organisms to different environmental factors they will study in the classroom setting, it is important for them to see at least some of the environmental changes occurring outdoors. The activities in this part help children relate the indoor activities and situations to the real drama of animals scurrying for cover, harvesting and storing food, digging into the soil, and doing whatever else they must, to survive the environmental changes. Plants die or become dormant (or flourish and flower) not because of the season, but rather because of individual environmental factors such as day length, temperature, available moisture, and many others.

While carrying out the activities in Part Two, your students will observe organisms outside the classroom. They will discover changes occurring in the environment and in the organisms. The children will observe and record the appearance of plants and animals in their neighborhood. In the fall, for example, they may note that the grass is yellow and presumably not growing. Having observed the organisms as they are now, they will be more likely to notice changes that occur later in the year. For instance, they may note and record (1) the return of robins (a change in location), (2) plants growing from seeds (a change in stage of life cycle), and (3) the appearance of leaves on trees (a change in structure), along with the changes in the environment. Thus, you have focused their attention on the organism-environment interactions that are not easily observed in the classroom.

The activities in this part are best done in either the

Figure II–1. Observing environmental changes in early spring.

fall or the spring when the changes are most obvious to the children.

The position of Part Two in the "Schedule of Activities" is set up for fall. If you use the *Environments* unit in the spring, we suggest you delay the use of this part until your climate begins to change. Using Part Two after Parts Three or Four presents no conceptual problem.

OVERVIEW

The activities in this part extend over several months and are intended to supplement experiments the children carry out in the classroom. In Chapter 5, "Recording Changes in the Environment," the children learn how to record changes in the local environment. While on field trips (Chapter 6, "Changes in Organisms") students observe and record changes in organisms and in the environment around the school. Recording and discussion sessions may be interspersed throughout the other activities in the unit. An experiment to see the effect of one environmental factor is carried out in Chapter 7, "Light and Plant Growth." From the variance in plant heights, children learn that there is variation in the growth of plants. Questions about other specific organisms and environmental factors may be investigated by groups of students, as optional activities.

GETTING READY

Find the best possible spot for the field trips described in Chapter 6.

5 Recording Changes in the Environment

SYNOPSIS

Over the next several months, the children record their observations of environmental changes on a chart and on graphs. The methods of collecting and recording data will be used during the field trips described in Chapter 6.

Suggested time: ***One class period is sufficient for the initial activity, but observations and recording occur over the remaining months of this unit. After initiating this activity, proceed with Chapter 6.***

TEACHING MATERIALS

For each child:

student manual page 8

For the class:

felt pen*

Drawer 1

Outdoor Changes Graphs and Chart sheet

Drawer 4

thermometers

Drawer 6

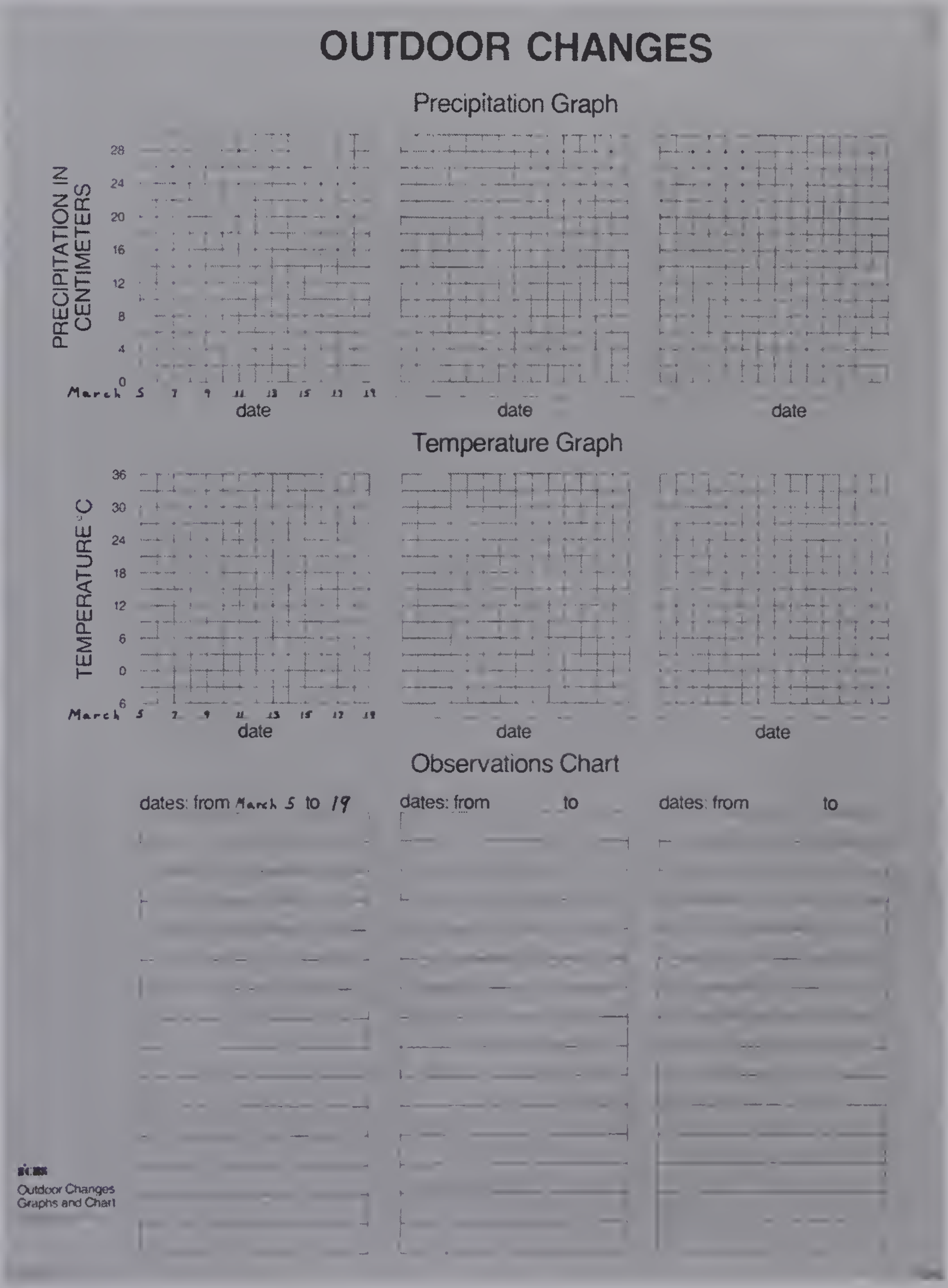
adhesive dots (50 green, 50 red)

* provided by the teacher

ADVANCE PREPARATION

Place the date when observations and recordings of precipitation and temperature are begun under the first vertical line of each graph. Continue dating the graphs through at least fifteen days. Write the inclusive dates of the first fifteen-day period above the first column of the observation chart (see Figure 5-1).

Figure 5–1. Be sure to label each column by date before beginning. Unless weekend changes are recorded, columns for those days should be left without any adhesive dots; this provides a more realistic picture than if Friday and Monday observations are shown in adjoining columns.



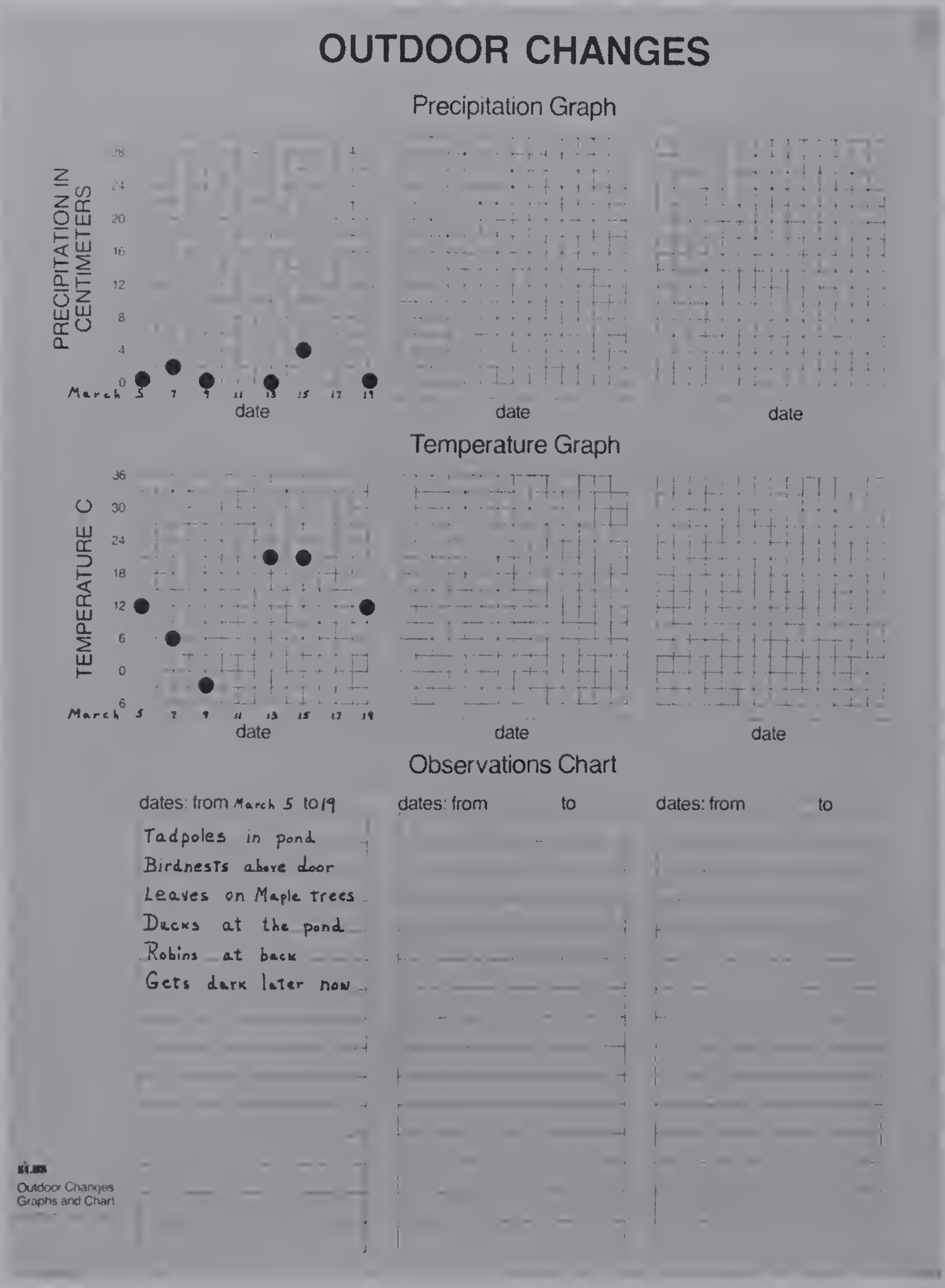
TEACHING SUGGESTIONS

With the measurement of precipitation and temperature, the discovery phase of the environmental factors learning cycle is continued.

Discussion. You might begin by telling the children they will take several field trips in the following weeks to observe changes in populations outdoors.

- Give a few examples of obvious changes that occur in your area and then ask the children to describe what they have observed over the past few weeks.
- In the spring, they may mention the arrival of robins or the appearance of new parts of an organism (flowers on a tree or leaves on a bush). Your pupils may have noted the exit of a winter bird, the loss of fur from dogs and cats, or a change to another stage in the life cycle of an organism (a tadpole to a frog, a seed to a plant, or an egg to a young bird).

Figure 5-2. A partially completed classroom chart.



- As the children discuss these events, lead them to consider associated changes in environmental factors.
- Explain that they will look for changes in the environment on their field trips. These may be some generally observable seasonal conditions—longer days, spring rains, and warmer temperatures—associated with the appearance of tadpoles, sprouting plants, and hatching birds. (If this unit is taught in the fall, changes other than those mentioned would occur, but the principle is the same.)

Plan the first field trip as soon as the children have become familiar with the recording methods described below. Discussions of the children's observations are most valuable on the day after each field trip (approximately every two or three weeks for the remainder of the semester). If these sessions are held more frequently, the plants, animals, and environmental factors may not change enough to provide interesting discussion material. If, for some reason, you are limited to working within the classroom, the children can report changes in organisms and environmental factors they observe while going to and from school and by bringing in weather reports.

The field trips are discussed further in Chapter 6. Postpone taking the first one until the following records have been started.

Outdoor Changes chart. Post the Outdoor Changes sheet and tell the children that over the next few weeks they will use it for records of precipitation, temperature, and other observations. The graphs and chart are divided into fifteen-day segments so that trends in the two factors can be shown. If the children suggest recording data for other factors, the chart may be modified to include their suggestions. Or, you may wish to have them prepare a separate chart.

Recording precipitation. Call the class's attention to the precipitation graph. Explain that *precipitation* is any water that falls to the earth—rain, snow, hail, or sleet. The children should record precipitation daily to obtain an accurate record. You may designate certain individuals as recorders, or you may prefer to make recording a class activity. Use a red dot to indicate the amount of precipitation on each date when it is measured. Later, you can connect the red dots with a line to emphasize the trend in this factor.

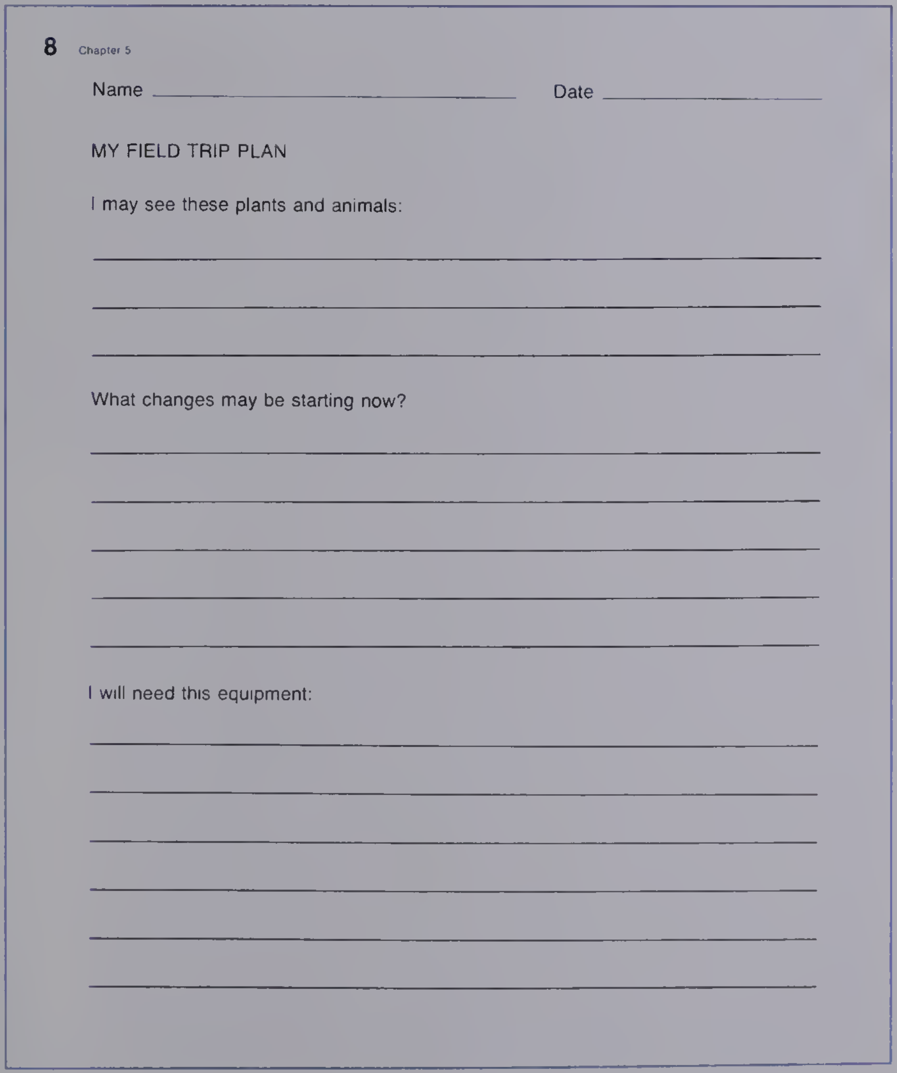
Recording temperature. Class recorders should also take the temperature daily, at the same time and place, placing a green dot at the intersection of the date and the temperature. (You may wish to connect the dots to help the children see a trend in this factor.) Figure 5-2 shows some sample recordings for one fifteen-day period.

If any of your students are unfamiliar with thermometers, allow a little time for them to practice taking temperature readings around the classroom. Explain that *20 degrees* can also be written *20°*.

Note. To convert Fahrenheit to Celsius, first subtract 32 from the Fahrenheit temperature and then divide by 1.8. To convert Celsius to Fahrenheit: first multiply the Celsius temperature by 1.8 and then add 32; or, use a double scale like that in Figure 5-3.

Using student manual page 8. After the class discussion, have each child make an individual plan for the field trips. This will not yield very sophisticated answers, but it will provide the children with a better idea of their goals.

Recording observations on the chart. Entries related to organisms and the environment will be recorded in the space provided, as children describe their observations. Each chart column should be used for a fifteen-day period. An example for the period March 5–19 is illustrated in Figure 5-2.



8 Chapter 5

Name ______________________ Date ______________

MY FIELD TRIP PLAN

I may see these plants and animals:

What changes may be starting now?

I will need this equipment:

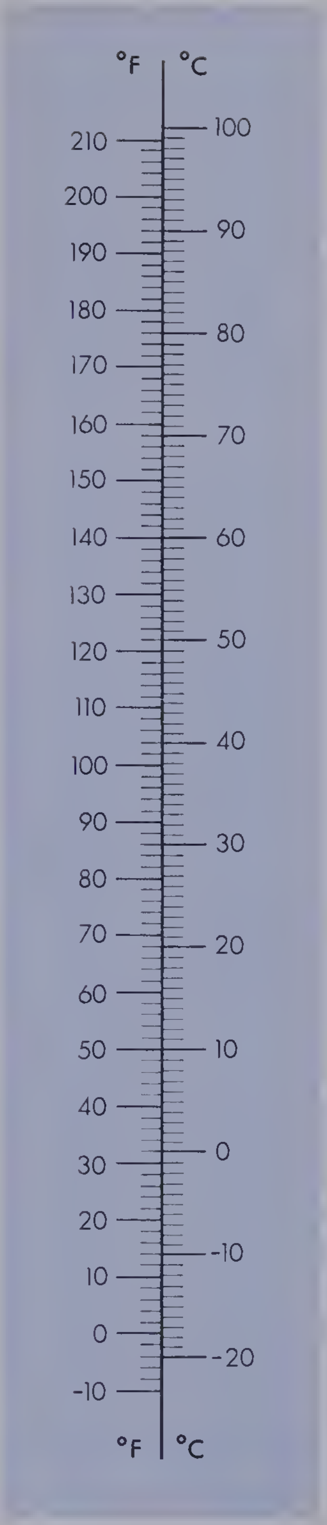


Figure 5-3. Fahrenheit and Celsius scales compared.

OPTIONAL ACTIVITY

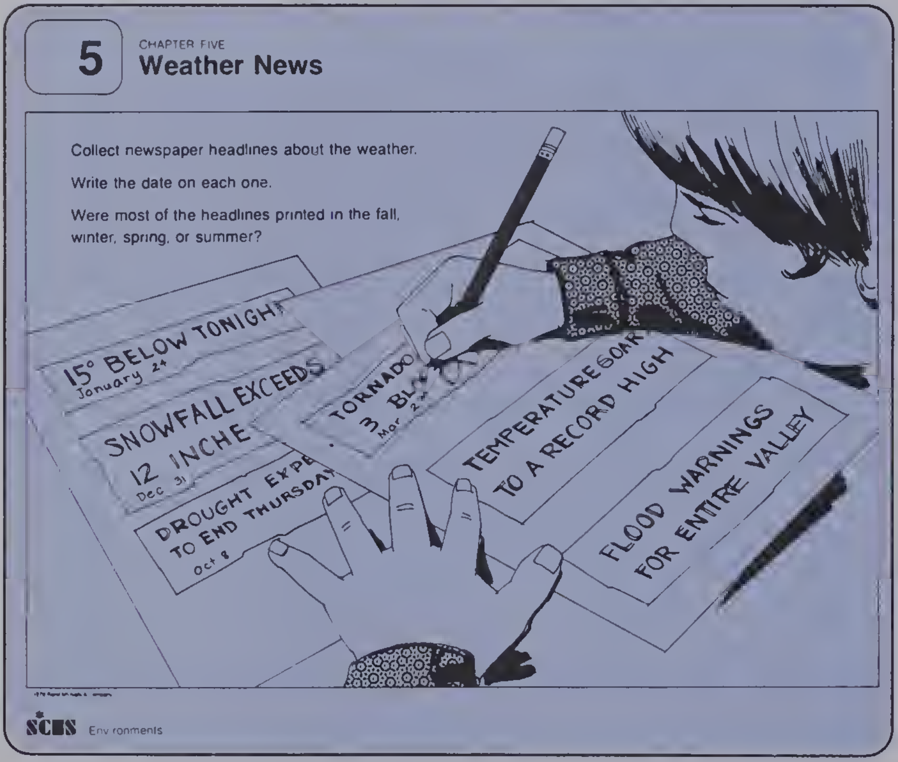
Using a rain gauge. If your class wishes to record precipitation more accurately, you may obtain an inexpensive rain gauge at a hardware store. The children may also construct their own gauge or simply keep a straight-sided container (such as a soup can) outside the classroom to collect rain, measuring and recording the amount of water each day. If you use a can, just measure with a ruler. Melt snow, hail, or sleet before measuring. The amount of precipitation in each fifteen-day period can be added and the total indicated on the Outdoor Changes chart.

EXTENDING YOUR EXPERIENCE CARDS

5. Weather News. Children selecting this card will need newspapers printed at various times during the year.

6. Check Your Weatherman. The students using this card will need a wide-mouth bottle or can for collecting precipitation, and a ruler for measuring. Encourage them to place the collector in an open, unprotected area. You will have to lend the student a thermometer, too.

7. Weather and Human Responses. No special help is required for a student choosing this card. A diary or calendar with writing space will be needed. Several students might want to work together on this project.


5

CHAPTER FIVE

Weather News

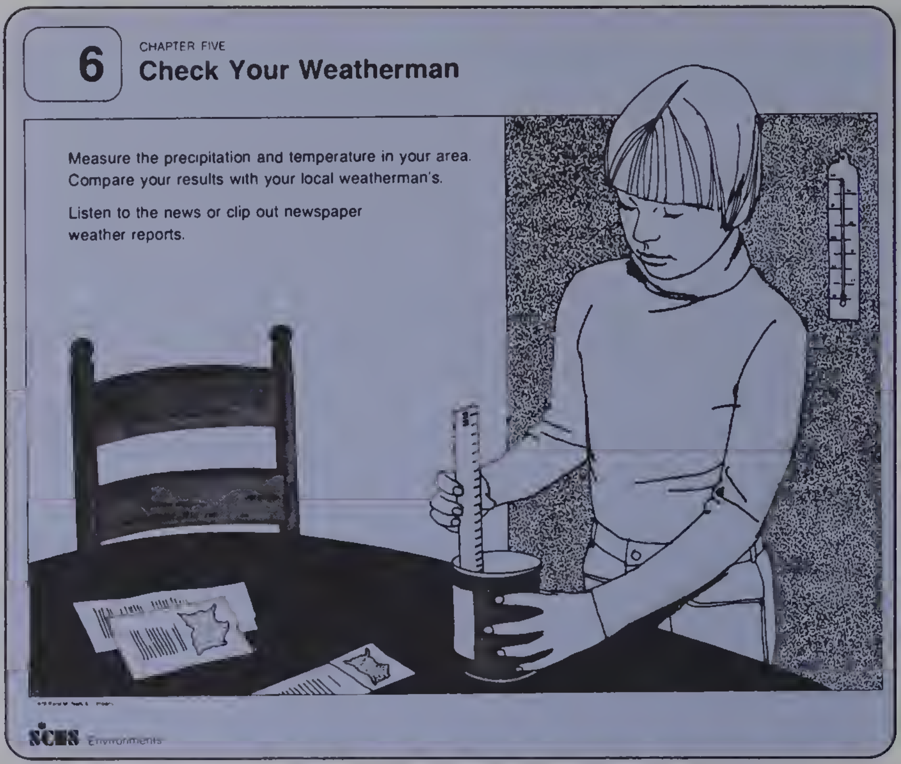
Collect newspaper headlines about the weather.

Write the date on each one.

Were most of the headlines printed in the fall, winter, spring, or summer?

15° BELOW TONIGHT
January 24
SNOWFALL EXCEEDS 12 INCHE
Dec. 31
DROUGHT EXPE TO END THURSDAY
Oct 8
TORNADO 3 BLA
Mar 2
TEMPERATURE SOAR TO A RECORD HIGH
FLOOD WARNINGS FOR ENTIRE VALLEY

SCIS Environments


6

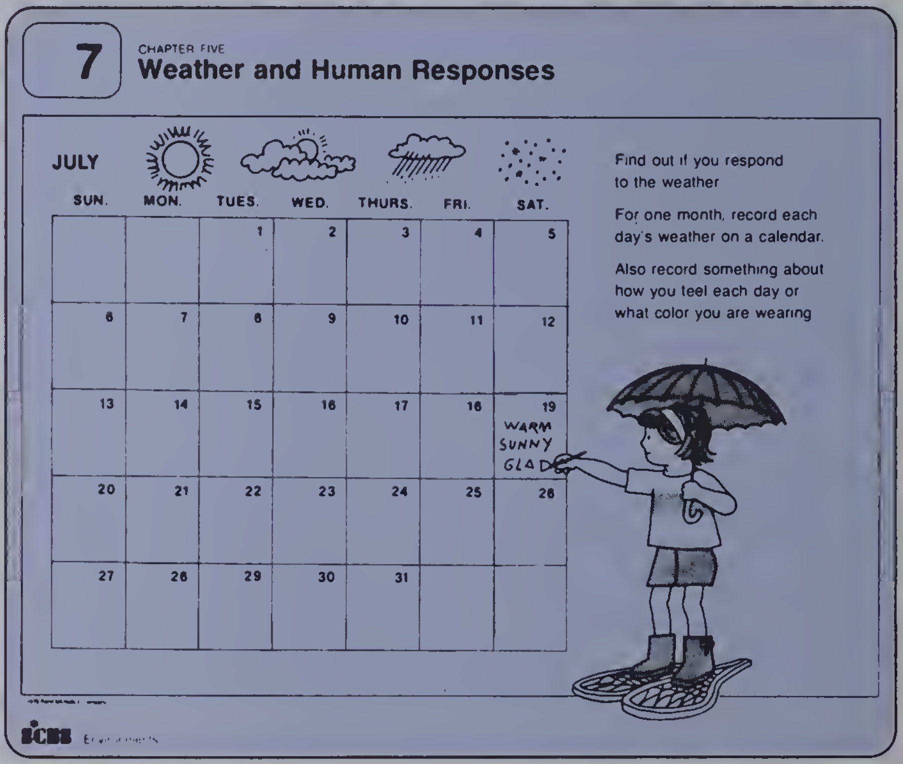
CHAPTER FIVE

Check Your Weatherman

Measure the precipitation and temperature in your area. Compare your results with your local weatherman's.

Listen to the news or clip out newspaper weather reports.

SCIS Environments


7

CHAPTER FIVE

Weather and Human Responses

Find out if you respond to the weather

For one month, record each day's weather on a calendar.

Also record something about how you feel each day or what color you are wearing

SCIS Environments

6 Changes in Organisms

SYNOPSIS

The children take several field trips so they can frequently observe changes in organisms and the environment. They discuss and make inferences about changes in the organisms that may be related to changes in the environment.

Suggested time: ***one class session for the first field trip. Thereafter, twenty-minute trips at two-week intervals should be sufficient.***

TEACHING MATERIALS

For each child:

1 student manual pages 9–11
notebook or paper *
pencil *
paste *

For the class:

Drawer 4

4 thermometers

* provided by the teacher

ADVANCE PREPARATION

Select a small, convenient area—part of a field, a vacant lot, or a section of the school yard—where children can observe organisms in their natural habitat. Look for an area in the vicinity of the school because you will revisit it frequently. Do not select a special park, zoo, or other such place which would require a long walk or a bus ride. It is not necessary, and the distance will interfere with the opportunities to visit it frequently.

TEACHING SUGGESTIONS

The discovery phase of the learning cycles for environmental factors and response continues as observations are made during a field trip.

Tell the children they will all take a field trip to the area you have selected. Explain to the children that they will visit this area several times during this semester (or year) in order to see what changes in organisms they can observe as the season changes. Have them review their field-trip plan on page 8 of the student manual.

Take four thermometers with you. Each child should carry a notebook or paper and pencil. The data they record will be useful for later discussion or reports. During this first visit, encourage the children to observe and record as much as they can. Upon returning to the classroom, you and the children can organize the information into an orderly scheme.

Figure 6–1. Recording the temperature.

Extending Your Experience card 8, *How Many Animals?* can be used at this time. Students using it will need 5 meters of string or thread, 4 wooden sticks, notepaper, and a pencil.

Extending Your Experience card 9, *Tag the Plants,* can be used on this first trip by interested students. Each student will need about 10 labels.

The field trip. Establish the boundaries of the study site and make these clear to the children. Areas 50 meters (165 ft) square are usually sufficient and still allow supervision of the children. Some teachers walk their class through the area as a group while looking for organisms and recording their data.

- Keep moving so the discoveries of plants and animals occur at a fast clip. Stop *before* the children lose interest.
- As a result of this first trip, the children should become more aware of the organisms living in the area, their activities, life cycle stages, and the obvious weather conditions.
- Depending upon your locale and the time of the year, the class may find trees with no leaves, weeds in bloom, geese flying north, or ice on a pond.
- The most obvious changes outdoors will probably be those occurring in the populations of annual plants. Seeds will be present in the fall and winter; in the spring, as the days become longer and warmer, most of these will germinate and produce young, rapidly growing plants. Most of these will flower and produce new seeds within a few weeks.
- Perhaps, instead of observing the organism itself, the children may find clues such as a shell, a feather, or an animal track. Encourage sharp eyes and the attitude of a detective during this field trip (Figure 6-2).

Note. Organisms found on the trip should not be removed from their habitats; the class will look for them again on later trips.

Organizing the data. Upon returning to the classroom, invite the children to share their discoveries with others if they did not search the site as a group. On the chalkboard, note the major headings emerging from their discussion, headings such as plants, animals, weather, soil conditions, air movement, light, odors, and sky conditions (Figure 6-3).

Using student manual pages 9 and 10. After the discussion, invite the children to select and order some of the organizing topics (or others of their own) on pages 9 and 10 of the student manual, leaving room for their observations under each. This is a practical approach to helping children learn how to organize a report and how to look for the changes between this trip and the next, while allowing for the characteristics of the site and the individuality of the children.

Figure 6-2. Finding evidence of an animal's presence.

Follow-up trips. Plan to take your students to the same area approximately every two weeks from now on so they can see changes that have taken place. Since the area will be close to the school, try to select times when some major changes are obvious. The children should return to the same area at least once. If they return only once, that date should be later in the year, separated as far as possible from the first field trip so that differences will be obvious. Encourage your students to take notes during every field trip and to record these observations on the Outdoor Changes chart afterwards. If more than two field trips are taken, the children can clip, paste, or staple the later notes into their student manuals.

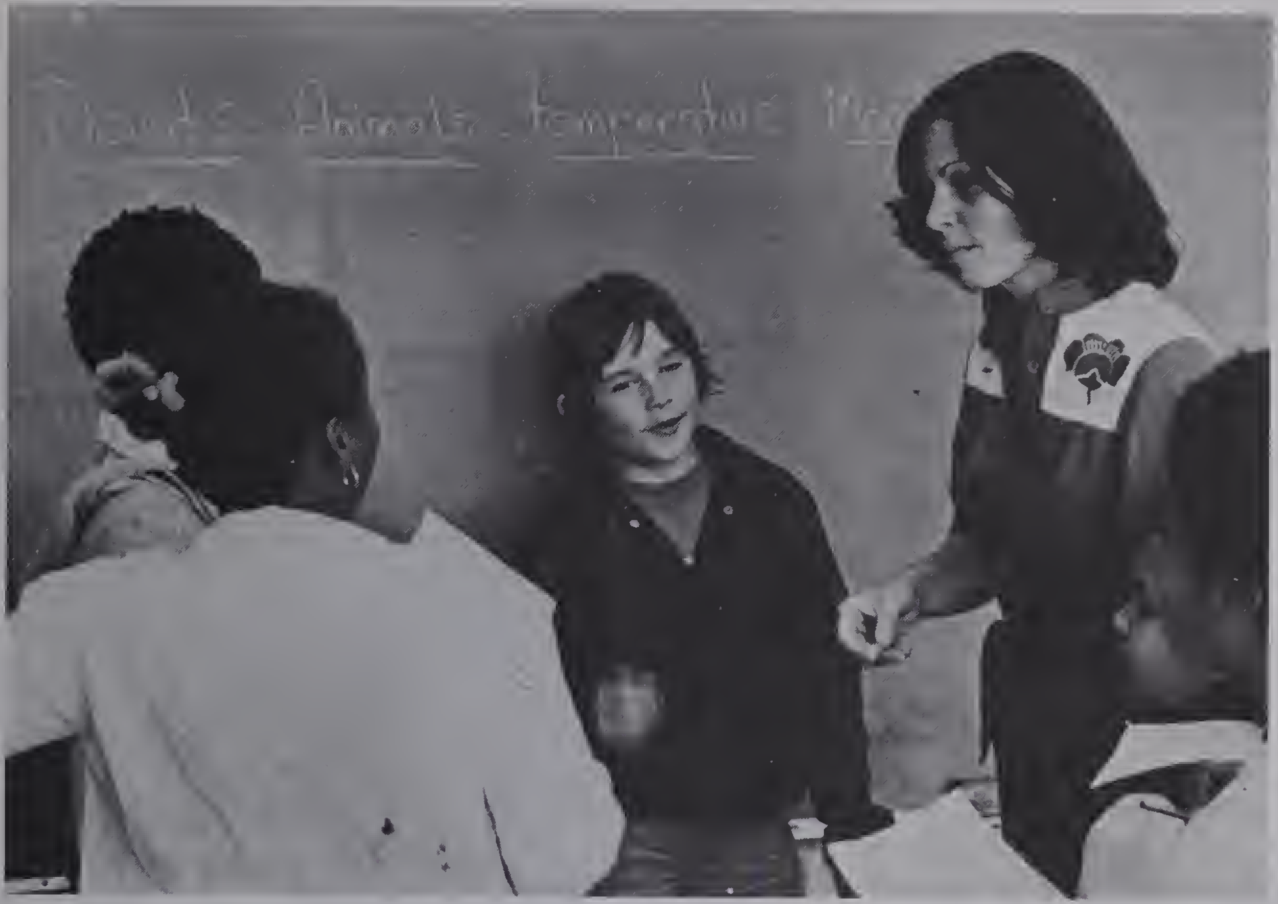
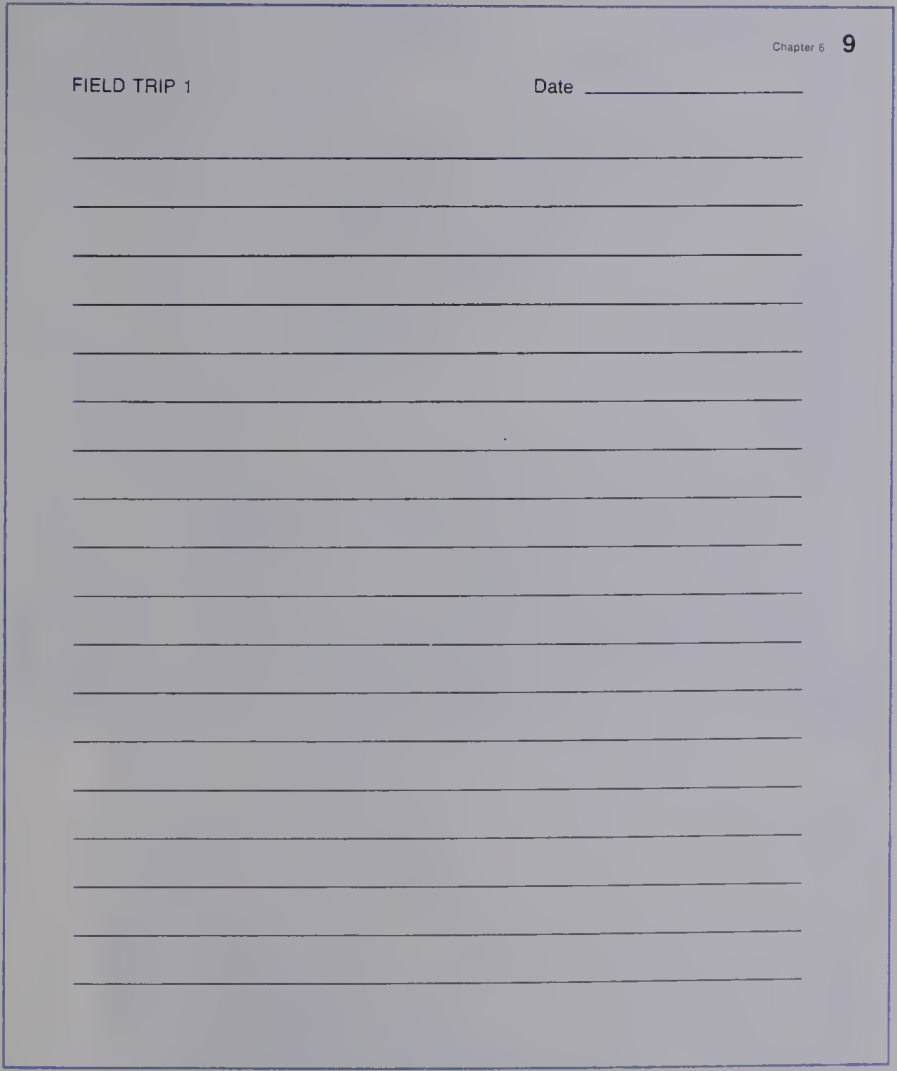
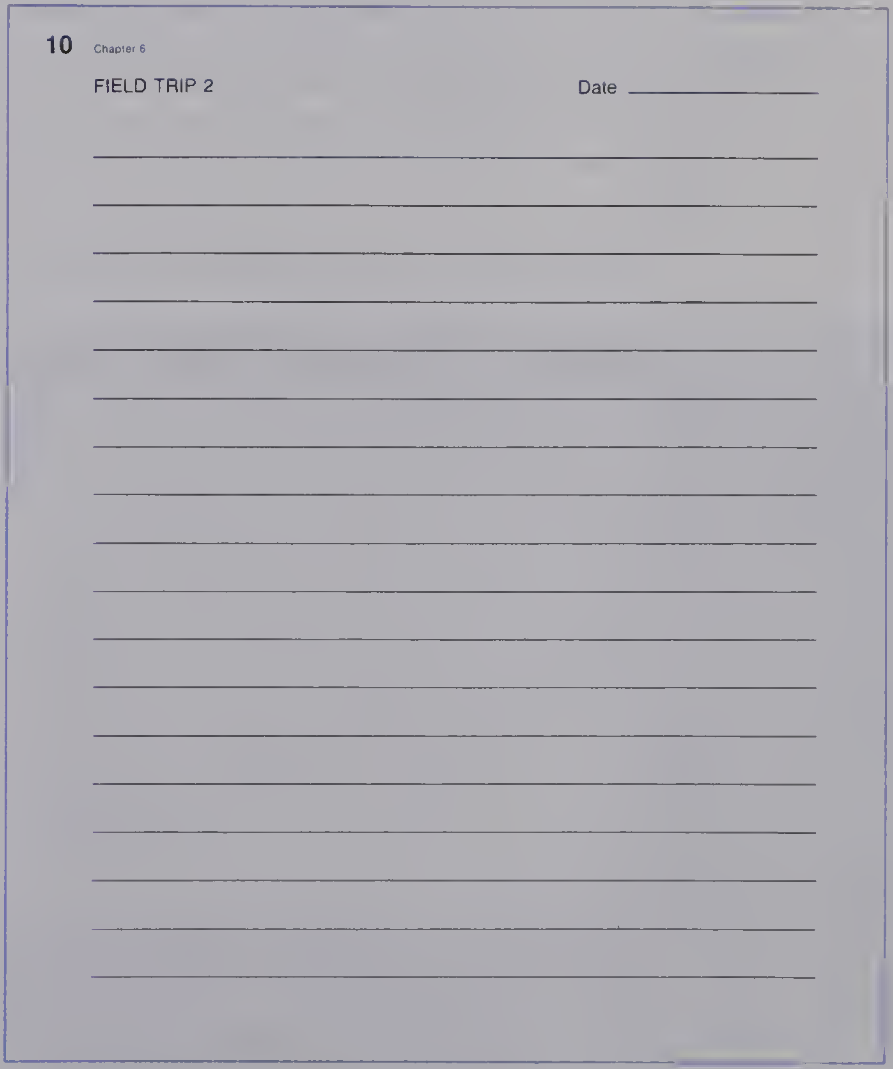


Figure 6–3. Developing organizing topics from the children's field trip notes.


Chapter 6 9

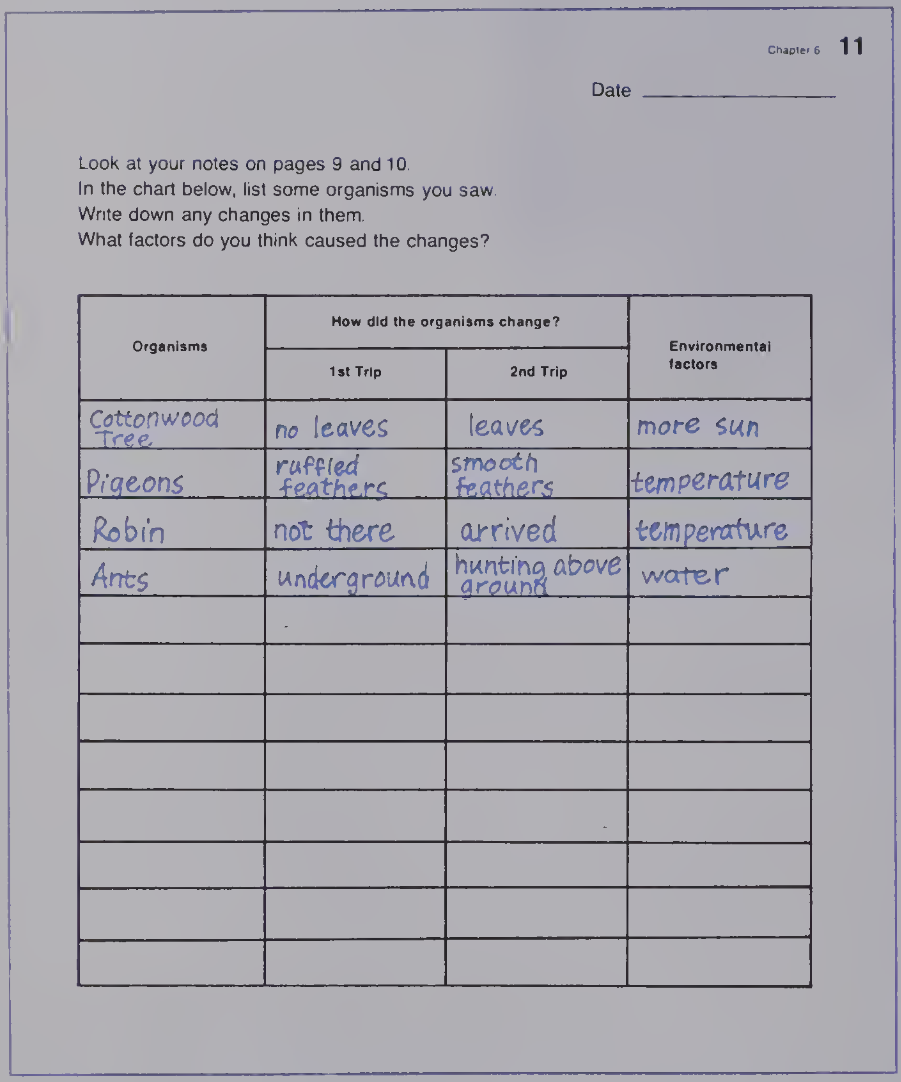
FIELD TRIP 1 Date ____________


10 Chapter 6

FIELD TRIP 2 Date ____________

Using student manual page 11. After you have taken the children on the last field trip, ask them to compare their reports from the first trip with those from this last one. They should list the organisms in the first column and tell how each organism changes in the second column. The environmental factor they think is responsible for the change in the organism should be written in the third column (Figure 6-4).

Figure 6-4. Sample data and interpretations entered on page 11 of the student manual.



Chapter 6 11

Date ______________

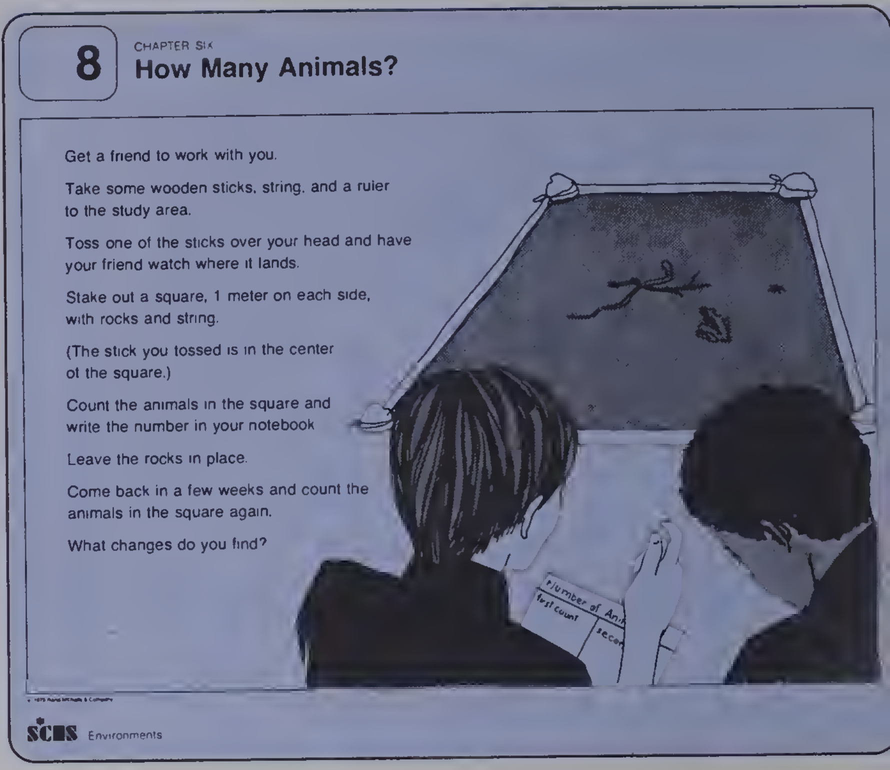
Look at your notes on pages 9 and 10.
In the chart below, list some organisms you saw.
Write down any changes in them.
What factors do you think caused the changes?

Organisms	How did the organisms change?		Environmental factors
	1st Trip	2nd Trip	
Cottonwood Tree	no leaves	leaves	more sun
Pigeons	ruffled feathers	smooth feathers	temperature
Robin	not there	arrived	temperature
Ants	underground	hunting above ground	water

EXTENDING YOUR EXPERIENCE CARDS

See page 28 for comments on using cards 8 and 9.

Extending Your Experience cards 1–9 are now available for the students' use. For equipment needed, refer to the list accompanying the set of cards.



8

CHAPTER SIX

How Many Animals?

Get a friend to work with you.

Take some wooden sticks, string, and a ruler to the study area.

Toss one of the sticks over your head and have your friend watch where it lands.

Stake out a square, 1 meter on each side, with rocks and string.

(The stick you tossed is in the center of the square.)

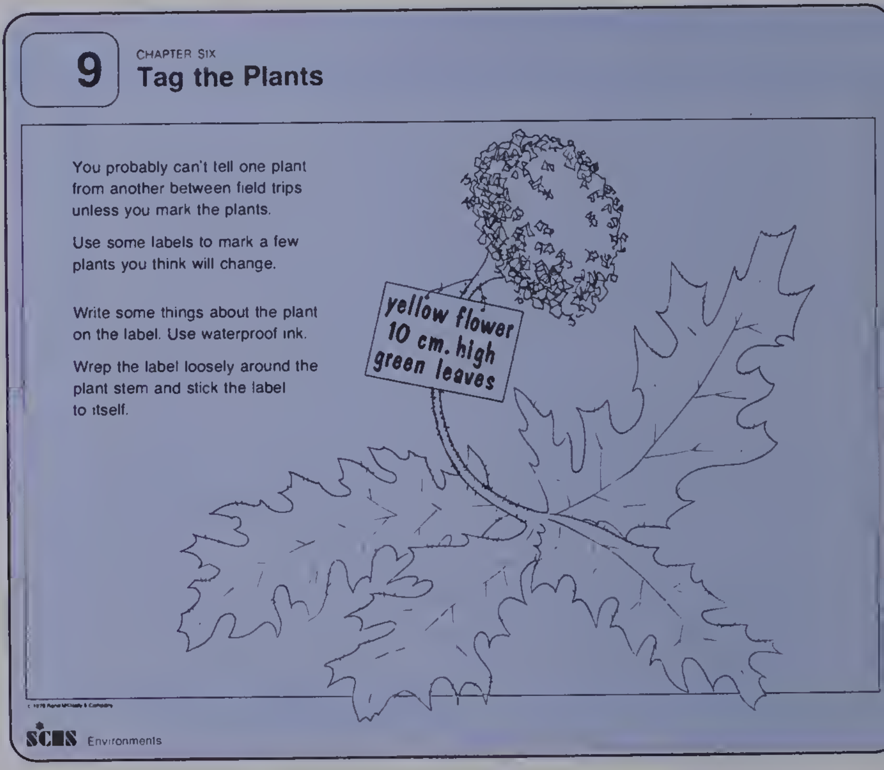
Count the animals in the square and write the number in your notebook

Leave the rocks in place.

Come back in a few weeks and count the animals in the square again.

What changes do you find?

SCIS Environments



9

CHAPTER SIX

Tag the Plants

You probably can't tell one plant from another between field trips unless you mark the plants.

Use some labels to mark a few plants you think will change.

Write some things about the plant on the label. Use waterproof ink.

Wrep the label loosely around the plant stem and stick the label to itself.

SCIS Environments

7

Light and Plant Growth

SYNOPSIS

Children plant seeds and measure the growth of the seedlings.

Children conduct a controlled experiment to determine the effect of light upon the growth of plants.

Suggested time: ***about two weeks. Begin Chapter 8 before you conclude this chapter.***

TEACHING MATERIALS

For each child:

student manual pages 12 and 13

For each team of two children:

3 crayons*

Drawer 3

- 2 sunflower seeds
- 10 tomato seeds
- 10 lettuce seeds
- ruler

Drawer 5

- planter cup
- planter base

For the class:

- cardboard box (optional)
- crayons*
- scissors*
- tissue paper*
- tape*
- felt pen*
- soil‡

Drawer 1

- Sunflower Response to Light chart
- Lettuce and Tomato Response to Light chart
- What Happened? picture

Drawer 3

adhesive dots (300 green, 100 red)

Drawer 4

- 4 water sprinklers
- planter sticks

* provided by the teacher
‡ Sand and Soil box

ADVANCE PREPARATION

Prepare three distribution stations, each containing about a third of all the materials necessary for the activity. Post the What Happened? picture where the children can easily see it.

TEACHING SUGGESTIONS

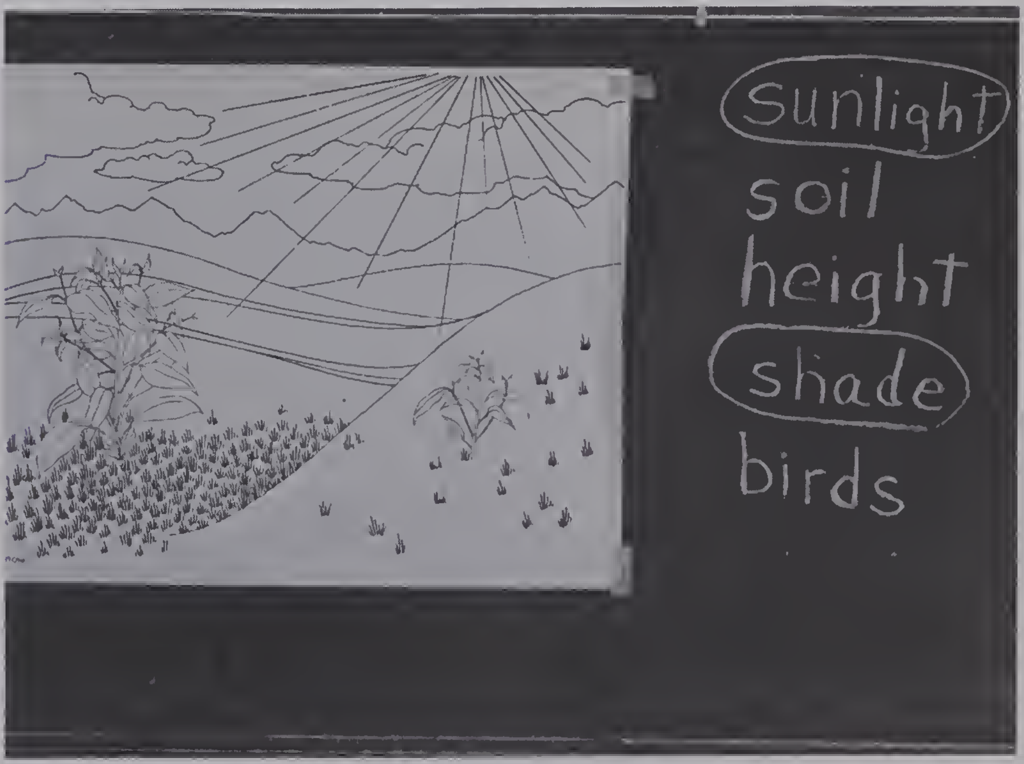
This activity is a discovery activity for the concept *response* and an exploration activity for the concept *plant growth*. The term *variation* is "invented."

What Happened? Point to the What Happened? picture and tell the students these two plants are of the same kind, and were planted at the same time. Encourage the use of the term *environmental factor* by asking what environmental factors may have been responsible for the responses of the two plants. Invite the children to speculate about what may have caused the two plants to grow differently.

As the students name the factors which may have been responsible for the different responses of the plants, list these on the chalkboard next to the picture. Children may suggest such factors as temperature, light, moisture, fertilizer, other plants, and animals. Someone may mention disease (which is really another organism).

Planning the experiment. After the students have named all the factors they can think of, circle the factors related to light and suggest that everyone experiment to find out just how light affects the growth of some plants.

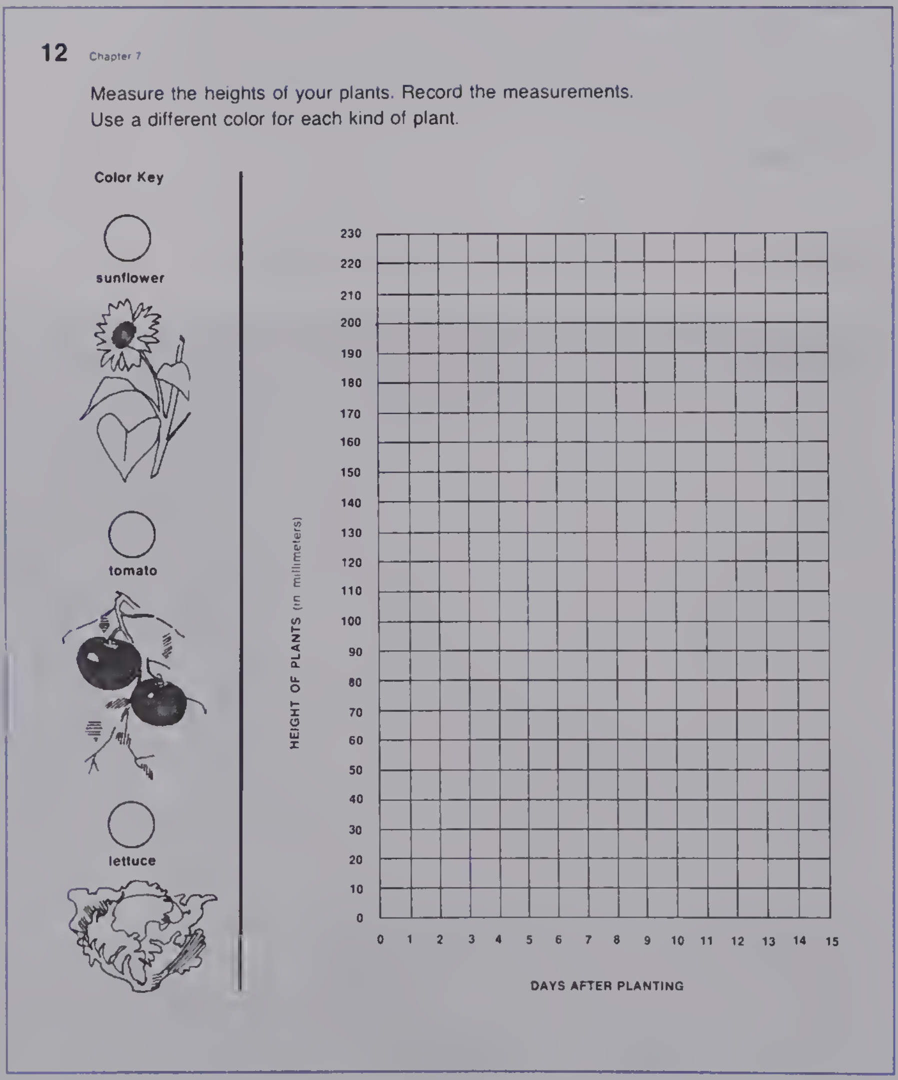
Figure 7–1. Circle the factors that are related to light.



The children may have some suggestions as to how to conduct this experiment. If so, let them assist. However, there will be ample opportunity for the children to plan many experiments later, after they have seen a few planned experiments such as this one.

Planting. Give each team of two children a planter cup, a planter base, and the seeds.

- Have the teams fill their cups with soil to the bottom of the frosted rim.
- They should plant the seeds by pushing them about ½ inch below the surface of the soil. (You need not direct the children to mark seed placement, as they will enjoy trying to identify their germinated seedlings.)
- Tell the children to add water to the top of the planters. The water will gradually soak in and wet the soil.
- Thereafter the children should water the planters every other day as necessary to keep the soil moist.
- After the initial watering, the children should label their planters by writing their names and the date on the frosted planter rims.
- They should place the planters near a window where they will receive some light. (The heat of direct sunlight may be harmful to plants; they cannot tolerate temperatures much over 40°C.)


12 Chapter 7

Measure the heights of your plants. Record the measurements.
Use a different color for each kind of plant.

Color Key

○ sunflower

○ tomato

○ lettuce

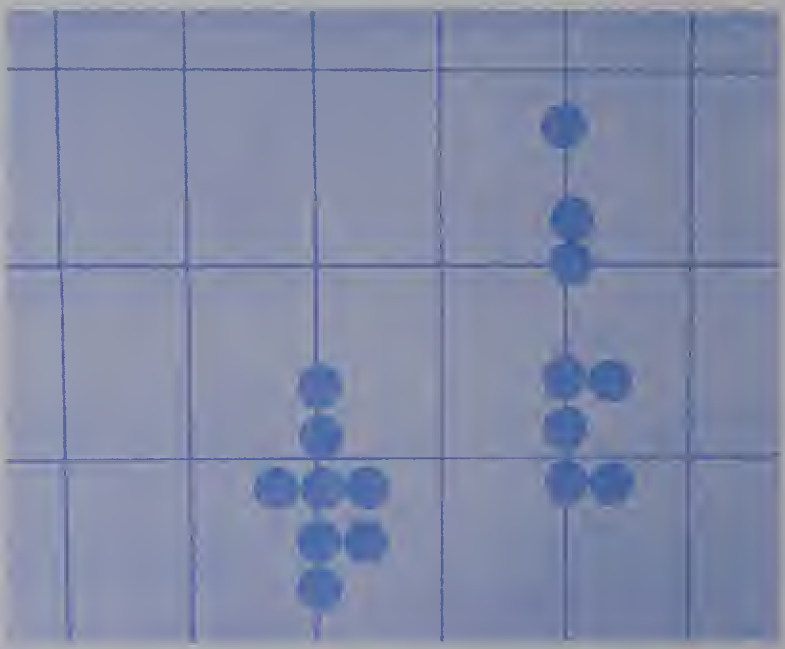


Figure 7–2. Dots should be placed next to other dots, never on top of them.

Recording plant growth: student manual page 12. When the children report plants appearing above the soil (about three to five days after planting), plan to have the first recording session. Give each team a ruler and ask the children to measure the tallest plant of each kind (from the top to the soil line). Discuss with the children how to record these data on page 12. A child should go along the horizontal axis until he reaches the number indicating the date after planting and then move up that vertical line and mark a dot at the height his team measured. Have children fill in the "color key" on page 12 so they will remember to use the same color for each plant during later recording sessions.

Display both of the Response to Light charts so the children can combine their data. Give each team three green dots so that data can be recorded on the charts. Remind the children that dots should not be placed on top of others, but rather separated enough so that each dot can be seen by the class (Figure 7-2). The children should measure the heights of their plants two or three times over the next week, recording these data on page 12 and on the charts. (If the sunflower plants become unwieldy, the planter sticks may be used for support.)

Averaging data. After the second or third recording session, it will be easier for the children to interpret their results if you teach them to average the data. One technique is shown in Figure 7-3.

Variation in plants. Not all the plants will sprout at the same time. Although there may be some discussion that some were planted deeper than others, some were watered more than others, etc., there is variation in the development time for all organisms. Take advantage of this obvious difference in sprouting by encouraging everyone to line up their planter cups so that their plant heights may be compared.

"Inventing" variation. While the children are lining up their plants, write the three plant names above three columns on the chalkboard. Have some rulers handy. As the children report the difference in plant height for the tomato, print the smallest and largest values for the height of that plant under "tomato," as in Figure 7-4. Before becoming involved with the next two plant types, get the children's attention and explain that this difference in development and growth is called *variation*. Further explain that when there is variation among plants of one kind (species), this is referred to as *variation within a species*.

Now encourage the students to find the variation among the lettuce plants. Record the shortest and tallest plant heights. Show the variation to the children and ask them what this variation is called when it occurs in the same type of plant. They should mention variation within a species. In a similar manner, let the students compare the sunflower plants.

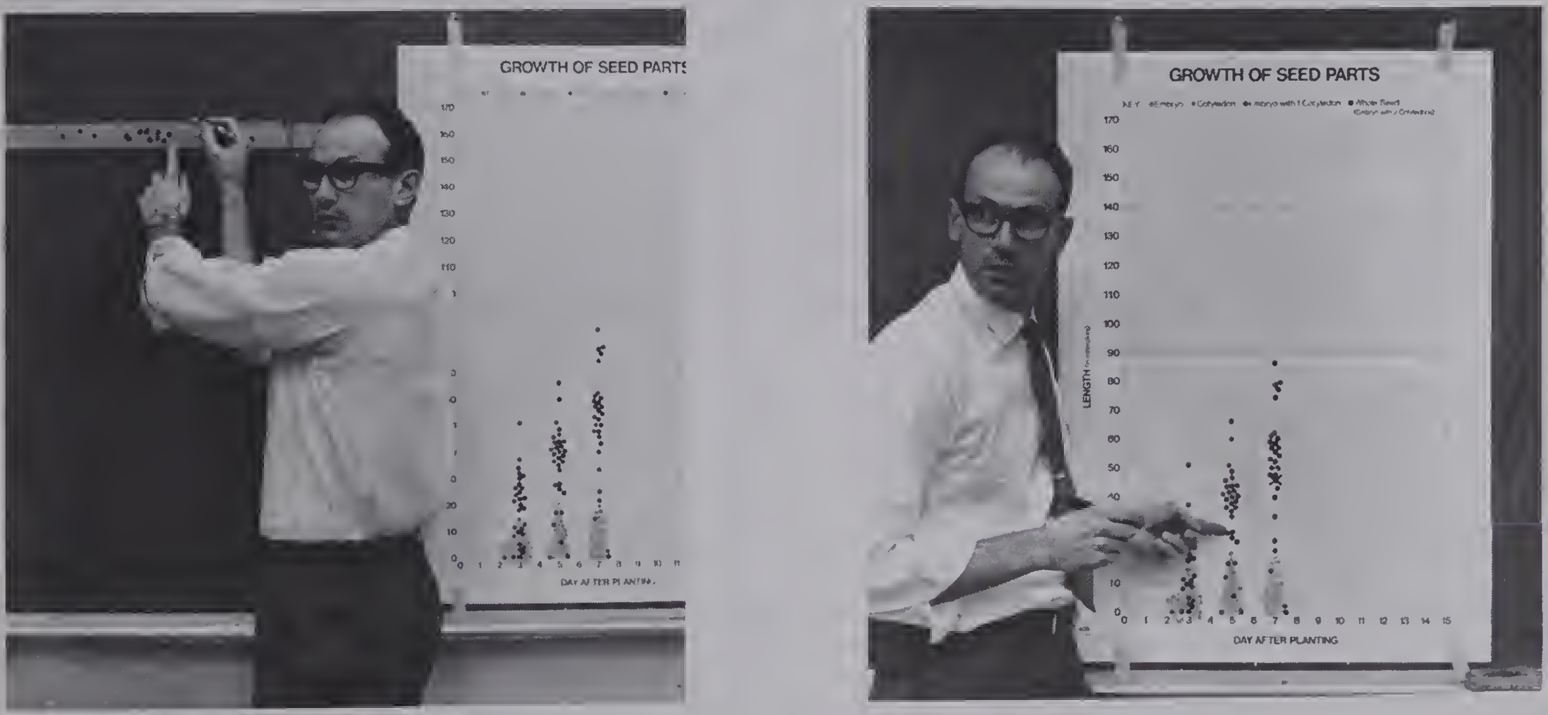
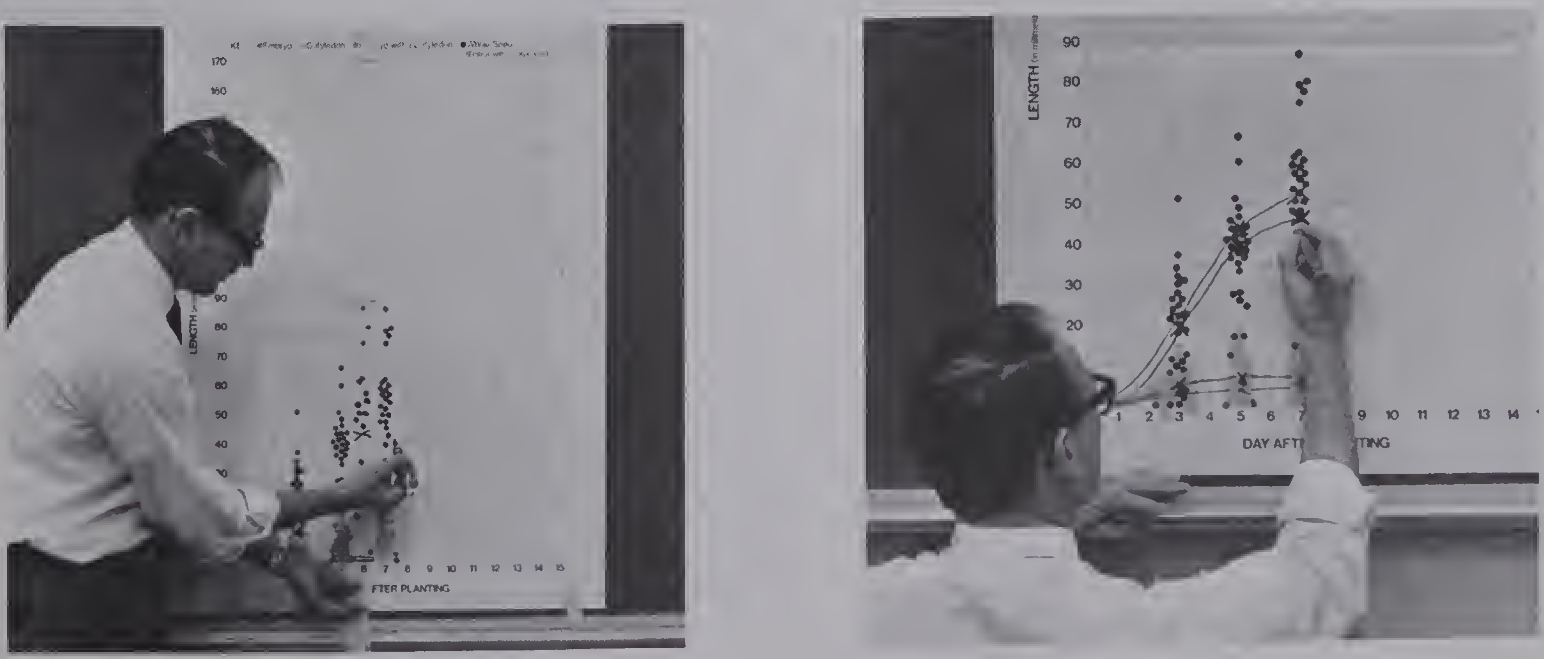


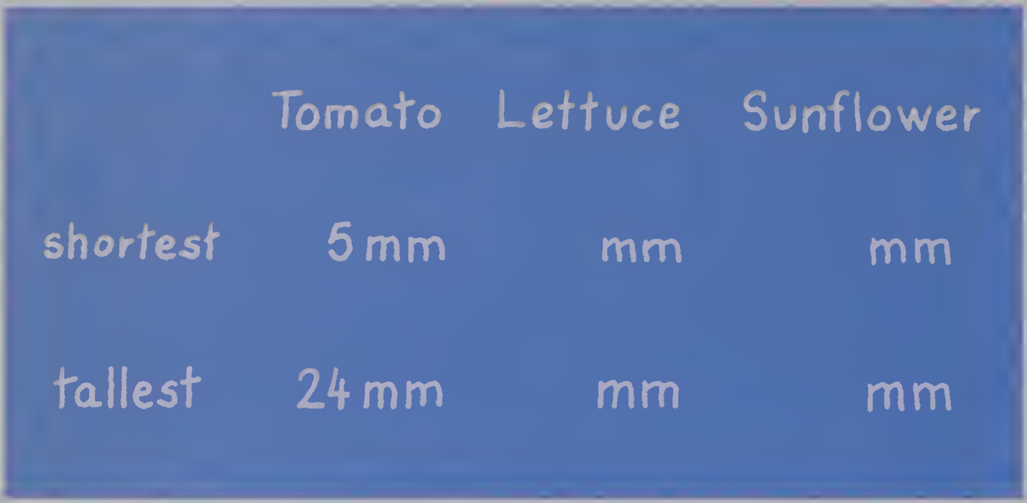
Figure 7-3. (a) Transfer one day's data to tissue paper. Ask the children to think of it as a seesaw and find the balance point.

(c) Turn to another day's data and find the average. Repeat for each day's data.



(b) Explain that the balance point on a seesaw is like an average point for data on a graph. Mark an X on the tissue paper, then transfer it to the corresponding point on the graph.

(d) Connect all the average points for each color to indicate a trend.



	Tomato	Lettuce	Sunflower
shortest	5 mm	mm	mm
tallest	24 mm	mm	mm

Figure 7-4. Illustrating variation within a species.

Note the maximum heights of the lettuce and sunflower plants. In this case, there are two different species (types) of plants. These two different species also vary. If you think that it is appropriate, you may explain to the children that this difference between two different species is called *variation between species*. There will be many opportunities to reinforce the children's understanding of these two concepts later.

This provides you the opportunity to apply the variation concept to plants. Ask the children to try to explain why there are differences in the size of their plants. If no one mentions variation, explain to the class that the difference in growth rates of plants of the same kind is another example of variation.

Changing the amount of light. After the children have measured and recorded the heights of the plants three or four times, ask them to predict what might happen to the plants if the amount of light were changed. Ask for evidence to support the predictions. How could they find out what would happen to all three kinds of plants in the dark?

If the children suggest placing all the plants in the dark and not placing any in the light in order to use a comparison, suggest that they leave some plants in the light.

The experiment. If the children have had experience growing plants in light and dark, you may wish to modify the following experiment to incorporate different intensities of light as suggested in "A range of light," page 35. Otherwise, proceed with the following experiment.

Combine the teams into two groups. Ask one group to place its plants in the closet. (A cardboard box placed over the plants could be used as an alternative method for keeping the plants in the dark.) Have each group label the planters appropriately *light* or *dark*.

Every two or three days for a week or so, have the children measure and record the heights of all the plants in the room on the same charts used earlier in this chapter. Heights of the plants growing in the dark should be indicated with red dots to distinguish them from the plants growing in the light. Because there are now two different situations represented on the charts, it is necessary to find two averages for each type of plant—one for those in the light and another for those in the dark. (You can write *light* or *dark* along the lines to indicate the appropriate average.)

In about five days, there should be a noticeable change in plant heights. When a plant dies, we suggest its height be recorded as zero.

Discussion. Discussion should follow each observation and recording session. Connect the average points to the previous average points and ask if there has been a noticeable change. Discussion topics might include the following:

- What differences are there in the two groups?
- To what factors might the differences be due?
- Does the sunflower respond in the same way as lettuce? As tomato?
- In what ways are they different?

This recording can be terminated when there is a definite separation in the pattern of the red and green dots on the charts.

Cleanup. The plants may be discarded, planted outdoors, or sent home. You may wish to store the soil for future experiments. If so, be certain your storage area is ventilated so that the soil will not become sour. Save the charts for later use.

Student manual page 13. The problem on this page may be completed at this time. The children's discussion about the event pictured should give you feedback about their understanding of light as an environmental factor. There are no right or wrong answers to the question. Encourage any and all hypotheses, such as: "Cows lie under one tree to get shade," "One tree sheds rain while the other lets it through," "Tree A lets more light onto the grass."

OPTIONAL ACTIVITIES

Bending toward light. Some of your pupils may have reported seeing plants turn toward the light. Let interested children investigate this phenomenon further. Lettuce and tomato seeds could be planted in containers (those provided in the kit or cutoff milk cartons) and placed in a part of the classroom where there is the least amount of natural light. Draw a line on one side of each container and orient that side toward the windows. As the seedlings grow, some may bend toward the light. The children may wish to turn the containers at intervals to see what effect this action has on the direction in which the plants bend.

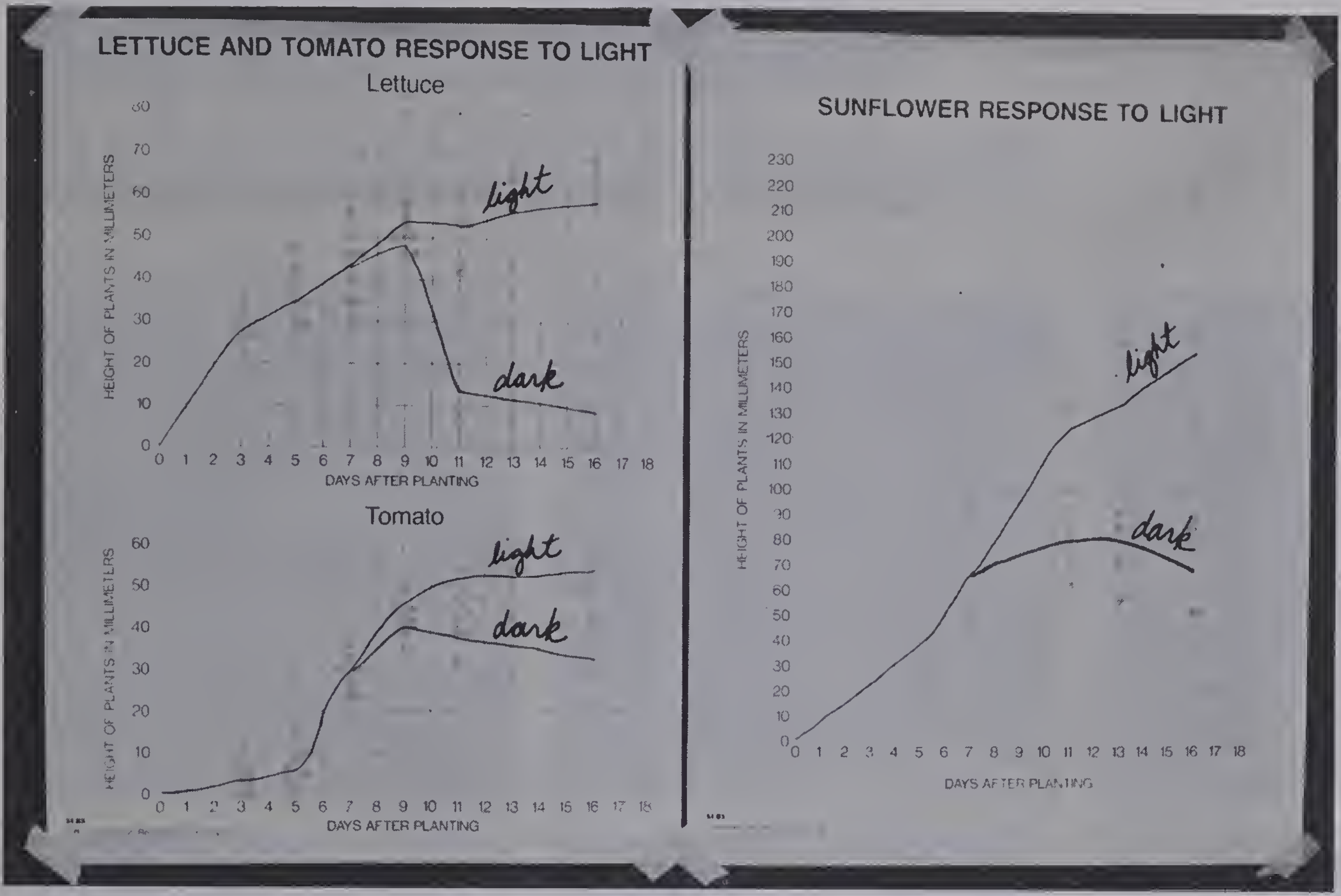
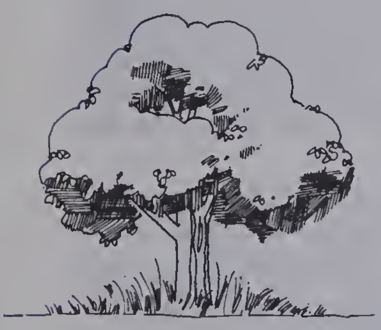


Figure 7–5. Evidence showing that plants respond to light.

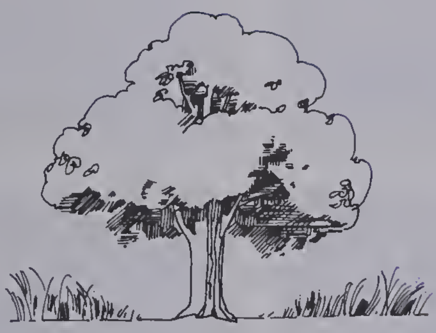
Chapter 7 **13**

Brain Teaser

Look at the grass in each picture.
What might have caused the differences in growth?



A



B

A range of light. Some of the children may state that the results of their experiments did not indicate an optimum range of light for plants. The plants were not grown in several different intensities of light, but only in the extremes of the range.

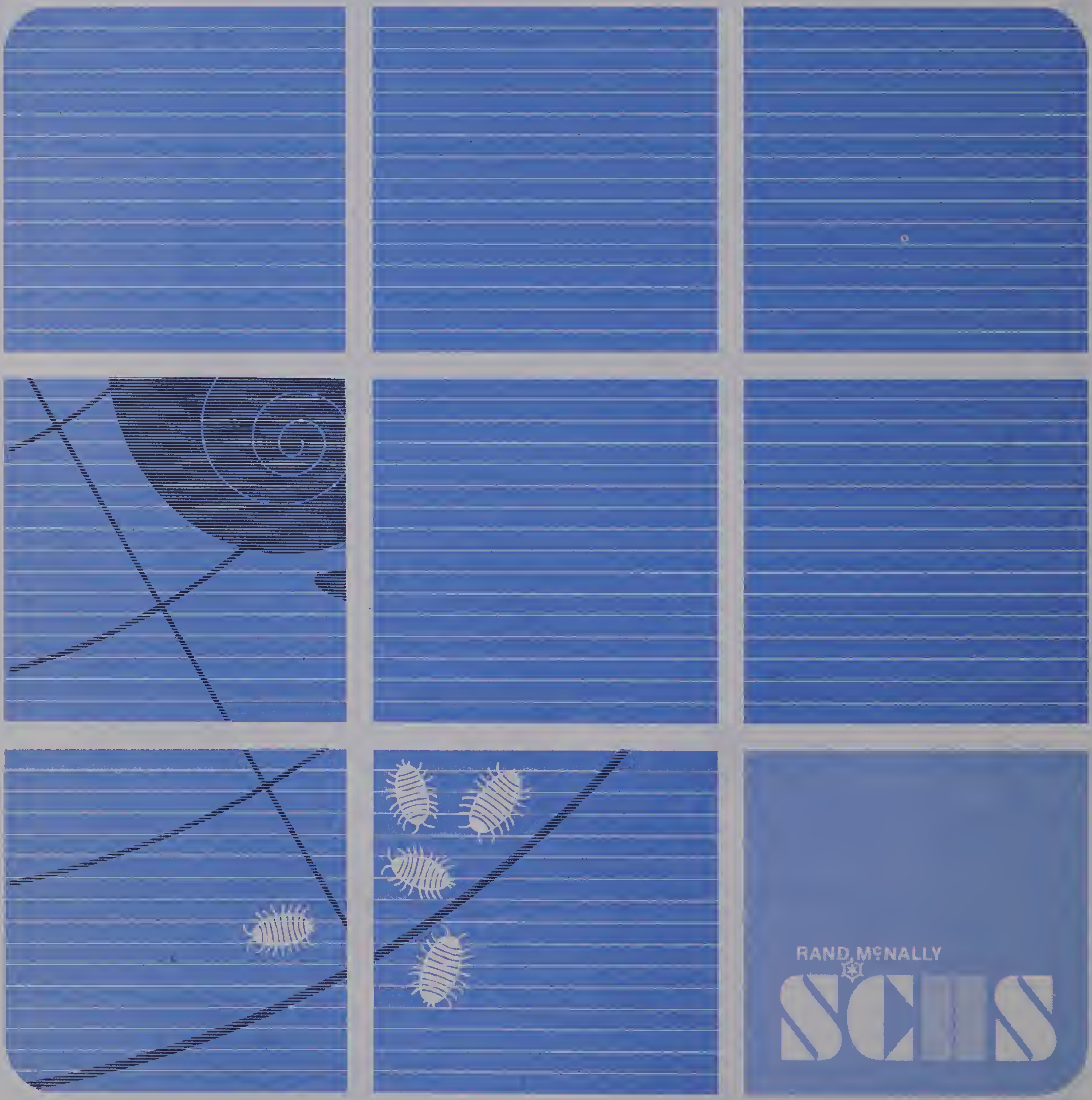
One way to provide a range of light is to grow groups of plants under cardboard boxes with differing numbers of holes cut in them. Place one group of plants (five or six) in a box with no holes, another group in a box with several holes, and so on until one group of plants has no box over it. As part of the experiment, they should also devise a method for recording data.

CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's understanding of responses to seasonal changes in the environments, turn to page 97 of the evaluation section.

GETTING READY
Order Live Organisms Shipment EN-1 for Chapter 11, using the form in drawer 2 of the equipment kit. Allow three weeks for shipment; when you mail the form, record the date on which you expect delivery.

Part Three



Plant Responses to Environmental Factors

OBJECTIVES

To describe the growth responses of plants under differing environmental conditions.

To conduct controlled experiments to determine the effect of one variable upon the development and growth of plants.

To determine by experiment the range and optimum of several environmental variables for plants.

BACKGROUND INFORMATION

Plants require certain environmental conditions in which to develop and grow to their maximum ability. If the environmental conditions are optimal, the plant will reach its maximum potential, but if any one of the environmental factors is not optimal, the plant may develop or grow improperly or not at all. Of the many environmental factors which affect plants, moisture and light are most familiar to us and are the most essential.

Most plants have access to the chemicals they need because they are exposed to the air and are typically rooted in soil which usually provides them with water and necessary minerals. Temperature is also important, but most plants have a wide tolerance for reasonable temperature variations and respond to non-optimal temperatures by developing more slowly than they would otherwise.

With plant roots being underground where we cannot see what is happening, and with the inability of plants to move from a poor environment to a better one, it is often difficult for us to determine what is wrong with a plant that appears unhealthy. For that reason, it is important to break the environment into its subparts, environmental factors, and to change one factor at a time in order to identify a problem or to improve the situation for a particular plant.

Plant populations survive in harsh climates as a result of specialized responses. For example, when the weather becomes cooler and day length shortens, deciduous trees shed their leaves and cease growth until conditions become more favorable.

Many of our familiar small plants, on the other hand, are annuals—that is, in the summer or fall the entire plants die after producing seeds. The seeds can survive summer dryness and winter cold. In the spring, days lengthen, temperatures rise, and the soil becomes moist from rain or thawing snow. Then the seeds germinate, beginning another spring and summer growing period. Thus the coordination of the plant's life cycle with environmental change ensures the survival of many plant species through the seasonal changes in most geographic areas.

Figure III-1. Could soil temperature affect plant growth?

Because the responses of plants to environmental changes generally occur over a long period, they are often less obvious to the observer than are the responses of animals. However, by raising plants under differing conditions and comparing growth, children can gather information on which they can base hypotheses about the optimum ranges of several environmental factors for plants.

OVERVIEW

In Chapter 8, "Temperature and Plant Development," the children investigate the effect of various temperatures upon two different types of plants in order to determine the effects of various temperatures on each type of plant. The experimental results indicate that grass is adapted to higher temperatures than clover. Bean seeds are planted in a range of moisture amounts in Chapter 9, "Plant Responses to Water," to determine the optimum amount of water necessary for beans to develop and grow tall. In Chapter 10, "Plant Responses to Chemicals," the children design and carry out their own experiments to establish the optimum amount of fertilizer for bean development and growth.

GETTING READY

You may want to have the children bring in some empty milk cartons for the optional activities and cleanup in Chapter 8. If so, mention it to the class now.

8 Temperature and Plant Development

SYNOPSIS

Children germinate seeds to determine the effects of several different temperatures on seed development.

Suggested time: ***two class sessions over a fifteen-day period during which the plants develop***

TEACHING MATERIALS

For each child:

student manual page 14

For each team of two children:

1 crayon*

Drawer 2

plastic trough
trough insert
metal strap
tumbler support

Drawer 3

ruler

Drawer 4

2 thermometers
tumbler

For the class:

empty milk cartons (optional)§
soil‡
5 100-watt light bulbs*

Drawer 1

Temperature and Plant Development chart

Drawer 3

5 bulb support rings
5 aluminum pans
500 tomato seeds
500 lettuce seeds

Drawer 4

4 water sprinklers
2 extension cords

Drawer 5

8 planter cups

In shipping carton:

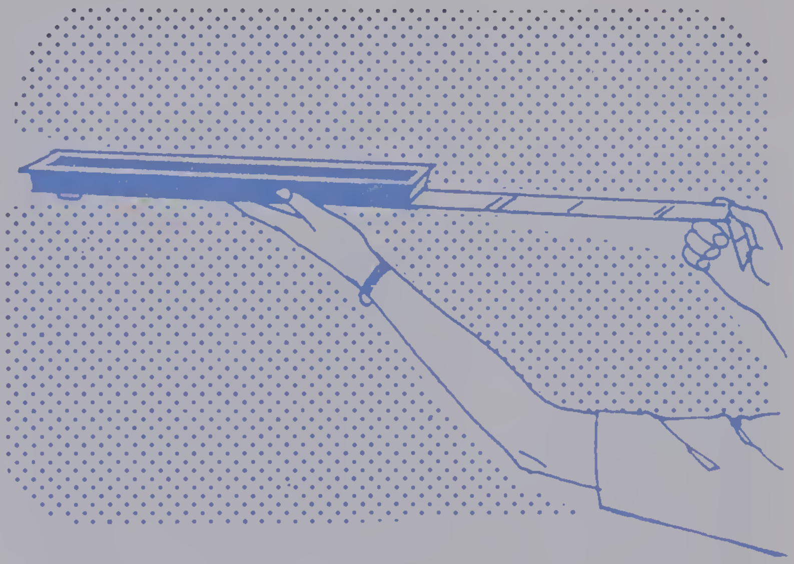
15 legs
5 socket/shade assemblies

‡ Sand and Soil box
§ provided by the children
* provided by the teacher

ADVANCE PREPARATION

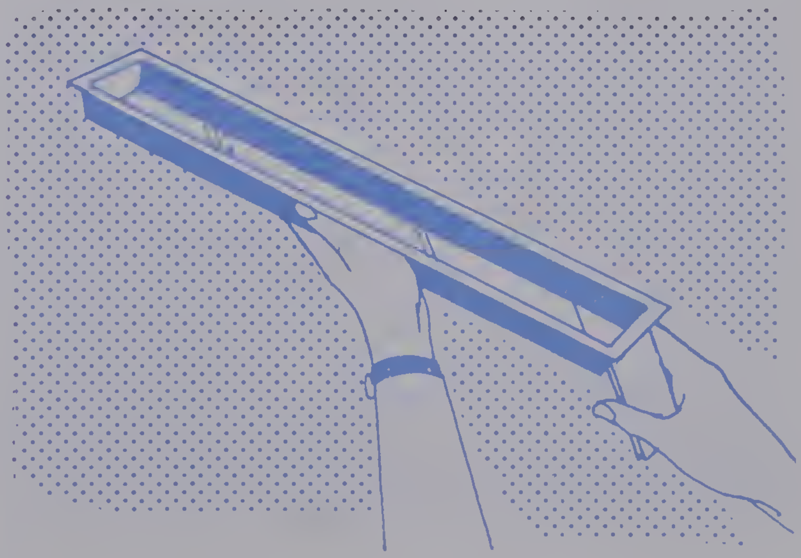
Get the materials out ahead of time, assembling and distributing them as follows:

Figure 8-1. Line up the trough and metal strap.



Assembling the trough systems. Remove the 15 plastic troughs from drawer 2. Also locate and remove the 15 long metal straps with the bent ends. Locate the slotted end of the plastic trough. Assemble the trough systems as shown in Figures 8-1 and 8-2. Hold a plastic trough with the top (open side) up and the end with the narrow slot facing you. Holding one of the metal straps with the bent part down, carefully slip the straight end of the metal strap into the plastic trough through the slot. Work the metal strap all the way to the end of the trough. Check to make certain the bend in the metal strap turns downward from the trough when the open end of the trough faces up. Assemble the remaining 14 trough systems in the same manner.

Figure 8-2. Push the strap to the end of the trough.



Setting up the light/heat source. Take out the 5 socket-shade assemblies, the 15 legs, and the 5 light bulbs. Refer to Figures 8-3 and 8-4 and assemble each light/heat source as follows: Insert three legs into the three leg sockets located around the rim of each light/heat source shade. The rubber tips of the legs should be oriented toward the narrow part of the shade, so that when the system stands on the legs, the open end of the shade faces upward. Insert a light bulb in each completed light/heat source.

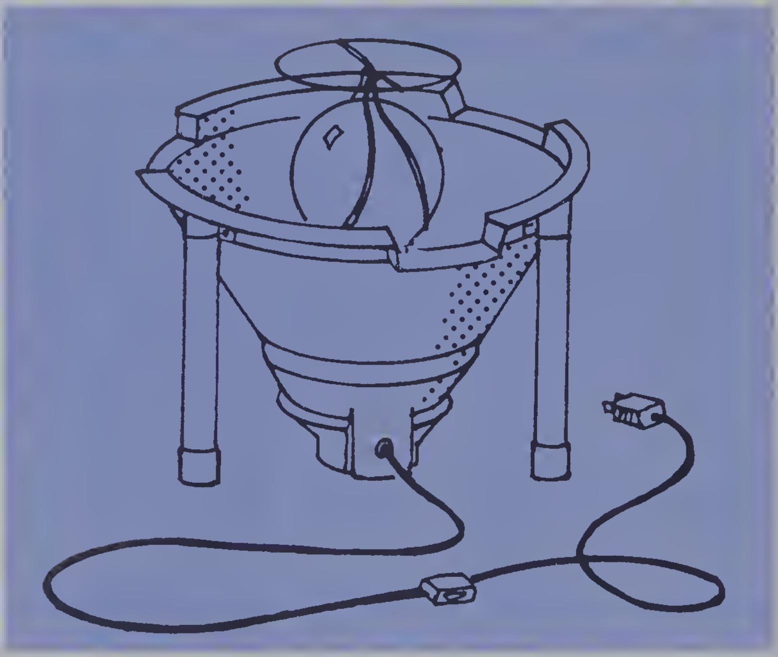


Figure 8-3. Assemble the light/heat source as shown.

Now locate the 5 bulb support rings and the 5 aluminum pans. Place each bulb support ring over 1 of the light bulbs so that the spring holds the bulb. Invert an aluminum pan over each support ring to form a shade, shielding the eyes from the light. Plug in the light/heat sources to see that each works. The switches are on the cords. Two extension cords may be found in the kit allowing you more flexibility in arranging light/heat sources.

Assembling the entire system. After you have placed the 5 light/heat sources in "out of the way" yet accessible areas, slip 3 of the metal straps onto the shade of each light/heat source. For this chapter, the troughs need not fit into the 3 notches in the rim of each shade; you can shape the system to fit onto a narrow table or counter top (Figure 8-5). Under the far end of each trough, place a tumbler (right side up) so the short plastic circle on the bottom of the trough is inside the tumbler rim. Place a tumbler support under each tumbler.

Set up 3 distribution stations, each containing some of all of the materials the children will use. Place 2 tumblers or planter cups in each soil bag for use as soil scoops and use 6 additional tumblers for seed distribution.

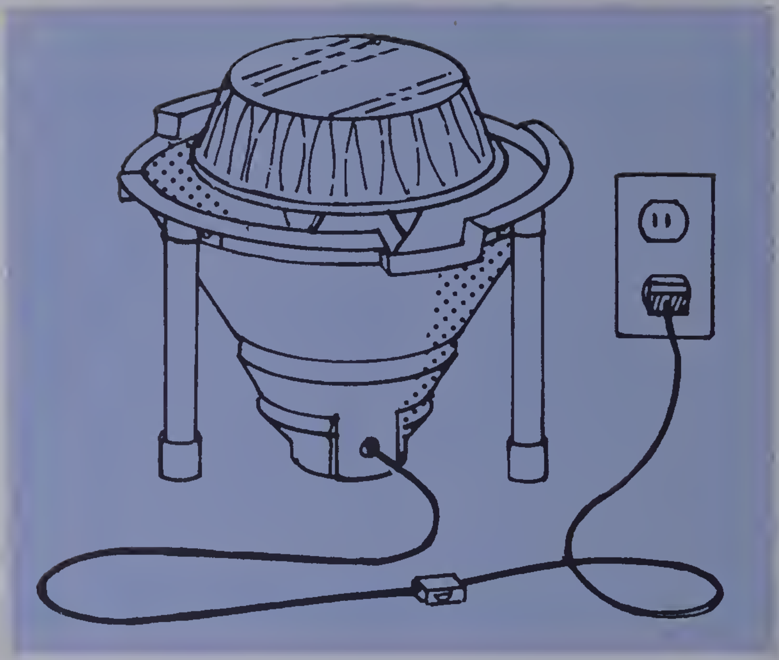


Figure 8-4. Add the aluminum pan and turn on the switch.

To facilitate distribution, you may want to list, on the chalkboard, the materials that each team will get from the distribution stations.

TEACHING SUGGESTIONS

This is an exploratory activity of the learning cycle for the idea that plant growth is affected by environmental variables. It also forms part of the discovery phase for *variation,* and the term *adaptation* is "invented."

Discussion. Remind the children of their discussions regarding the effects of the seasons upon the plants and animals, and of how the changes in weather seem to be related to the behavior of organisms. Ask whether they know how developing plants respond to different temperatures. After they have had an opportunity to discuss their various ideas, suggest that they experiment to find out, and show them the apparatus they will use.

Hold up one of the metal troughs and place a plastic insert in it. Tell them that the ten different sections can be filled with soil and then planted with seeds. Illustrate how the end of the trough with the protruding metal strap can be inserted into the light/heat source to make one end of the trough hot.

Planning the experiment. Tell the students that you have two different kinds of seeds—tomato and lettuce—and ask them how they could use this equipment to find out the responses of tomato and lettuce to different temperatures.

If they have trouble thinking of a way to use this system to determine the responses of tomato and lettuce to different temperatures, draw a diagram of the planter insert on the chalkboard and sketch two tomato and two lettuce seeds in each of the ten sec-

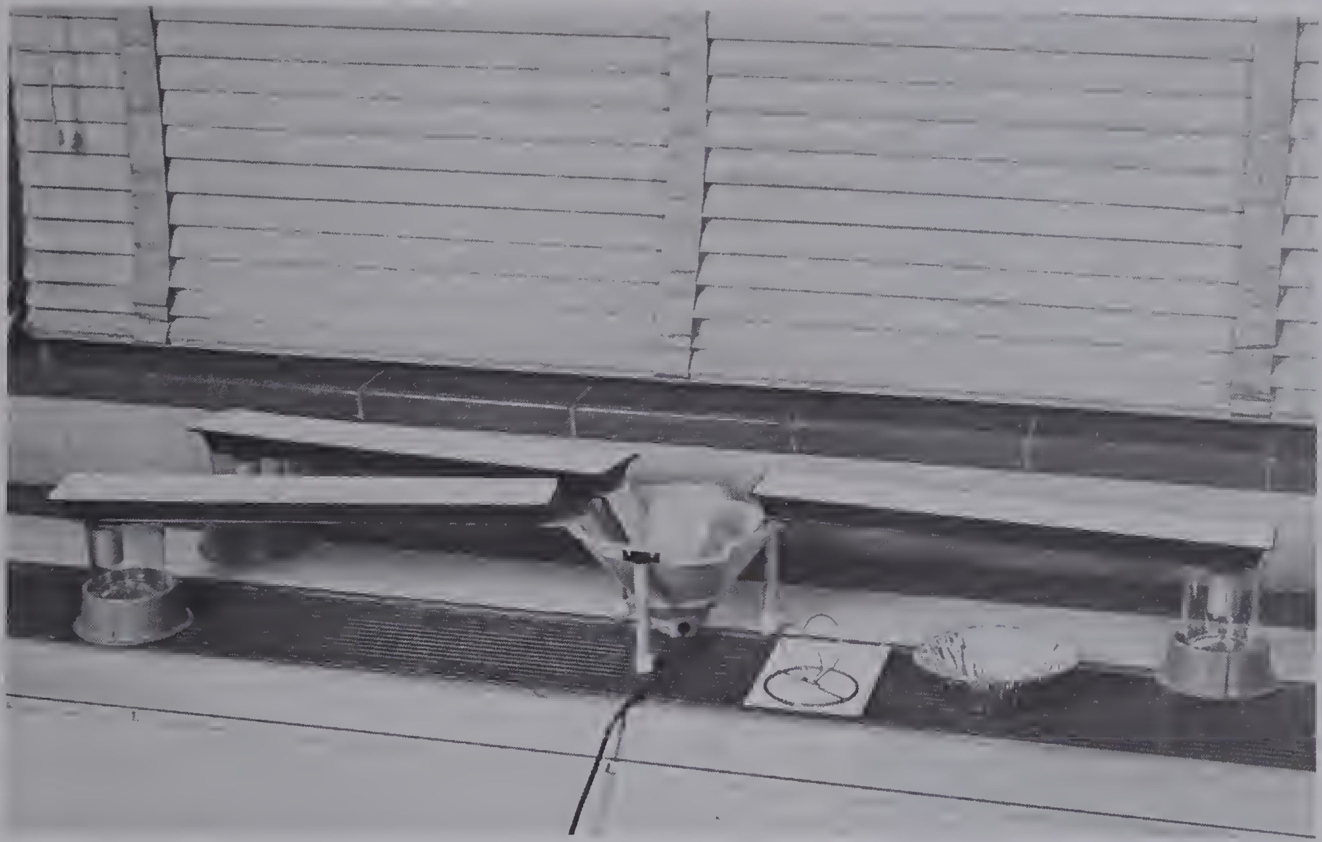


Figure 8-5. The experimental setup for three teams.

tions. Also sketch the light bulb under one end.

Ask how much water they should use in each section if they are to set one end over the hot light bulb. (Start out with the same amount and thereafter keep the soil in each section equally moist so that all seeds will have the same amount of moisture at all times.)

Divide the class into fifteen teams and let them begin their preparations. As they set up their experiments, walk among them offering whatever help they need. Some children may not know how deep to plant the seeds, whether they should compress the soil (very little), and how much water to use (enough to change the color of the soil—if you can squeeze water out of a pinch of soil, it's too wet; and if the soil crumbles after pinching it, it's too dry). Make sure that they plant all the tomato seeds along one side of the insert and all the lettuce seeds along the other.

When most of the children have completed their planting and before they have set their systems on the lamp, ask them to use a crayon to label their inserts with their names, the date, and the positions of the tomato and lettuce seeds. This marking should be on the end of the insert that is located away from the light source. They will be using the space along the sides for labeling later. Have them put the inserts in the troughs, and the troughs on the light/heat systems.

Leave the lamp on continuously for the next week or so (until the plants emerge and are about 3 centimeters tall). On the next day, or soon thereafter, ask each team to get their trough systems and to measure the temperature of every section of the insert (Figure 8-7). The soil will not cool rapidly, but there should be no unnecessary delay in measuring the temperature after the planter systems have been removed from the heat source.

Figure 8-6. The end of the trough insert should be labeled now.

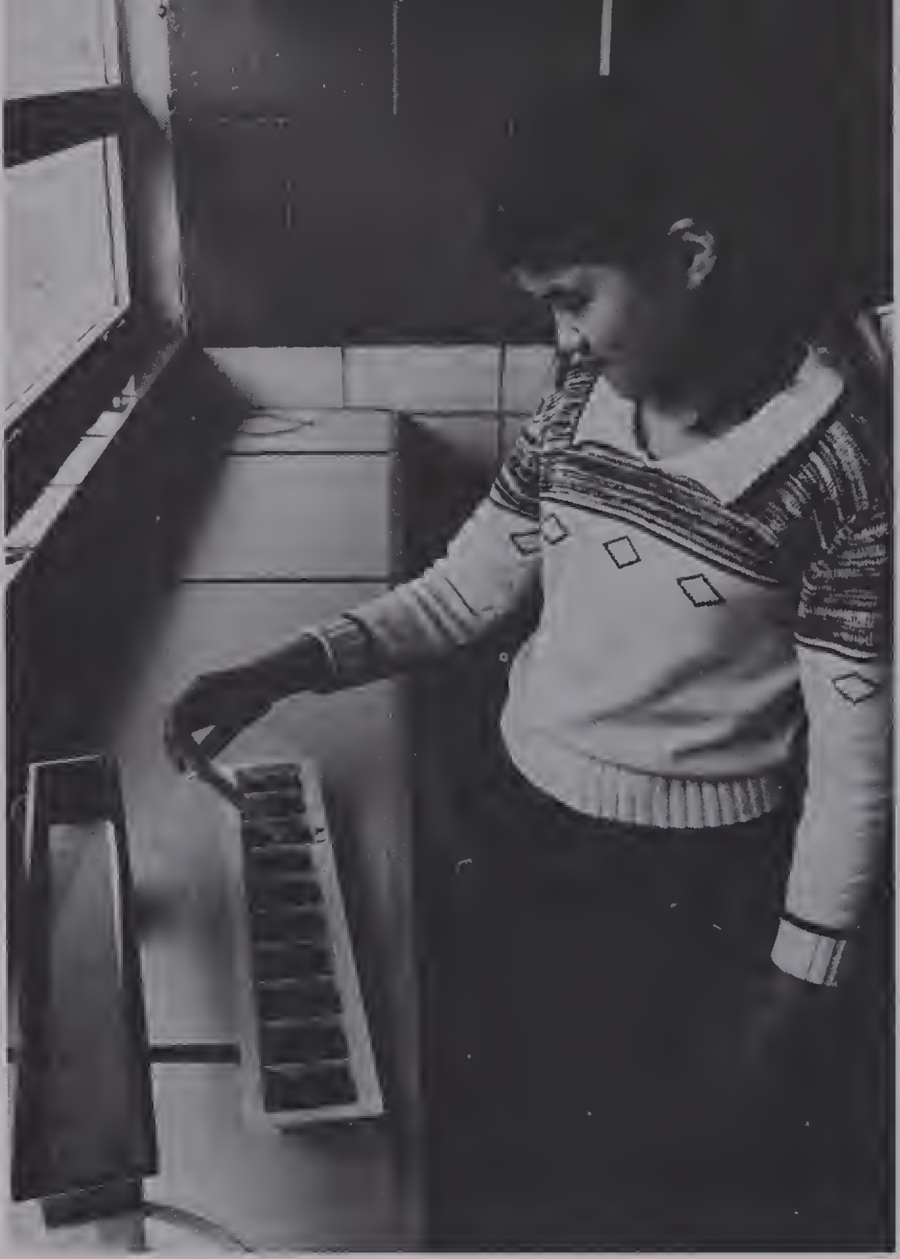


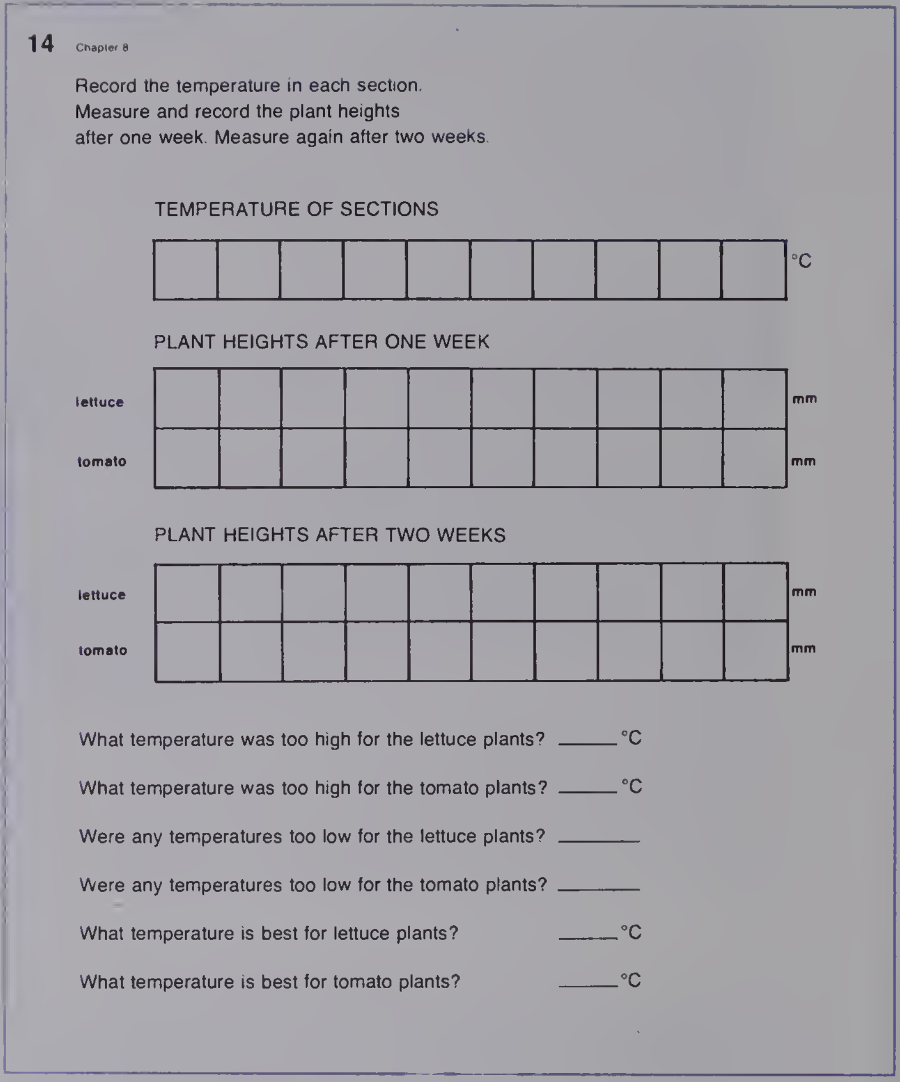
Figure 8-7. Measuring the temperature in one part of the system.

Using student manual page 14. Tell the students to write the temperature in each section on the sides of the inserts, and to record those values in the matching sections of the top illustration on this page.

Maintaining the plants. Encourage the children to observe any plant growth and to check the water in their soil every day. Only two measurements and recordings are necessary, but if the soil is not checked regularly and watered when necessary, the plants may die because of water deficiency rather than excessive temperature. If this happens, the experiment will not reveal what the plant responses are to different temperatures.

Measuring and recording. One week after the seeds were planted, organize a measuring session. Each plant which has sprouted should be measured and the tallest tomato in each section recorded in the matching section of student manual page 14. Likewise, each lettuce plant should be measured and the height of the tallest plant recorded in the appropriate section on page 14.

Two weeks after the seeds were planted, let the pupils measure and record the heights of the tallest tomato and lettuce in each section again. After they have completed the data tables, ask them to answer the questions at the bottom of the page before you hold the discussion. In this way, you will have an opportunity to see what interpretations they make based on their data before they have the opportunity to worry about the accuracy of their data.



14 Chapter 8

Record the temperature in each section.
Measure and record the plant heights
after one week. Measure again after two weeks.

TEMPERATURE OF SECTIONS

										°C

PLANT HEIGHTS AFTER ONE WEEK

lettuce											mm
tomato											mm

PLANT HEIGHTS AFTER TWO WEEKS

lettuce											mm
tomato											mm

What temperature was too high for the lettuce plants? ______°C

What temperature was too high for the tomato plants? ______°C

Were any temperatures too low for the lettuce plants? ______

Were any temperatures too low for the tomato plants? ______

What temperature is best for lettuce plants? ______°C

What temperature is best for tomato plants? ______°C

Analyzing the results. Post the Temperature and Plant Development chart and poll the class for their results by asking one person from each team to hold up his or her hand if they had a tomato plant develop in the hottest section. Write the number of hands you see in the hottest section for tomato. Do the same for lettuce and continue through the chart until all of the sections have been completed. After the master data chart has been completed, encourage the students to use the evidence to explain why there are some parts of the world where plants do not grow. Was one kind of plant able to withstand greater temperature than the others? Is that ability to be able to develop in high temperatures good for that plant? In what ways might it help the plant?

"Inventing" adaptation. Introduce the term adaptation here by writing it on the chalkboard and explaining that adaptation is a certain ability of a plant or animal which allows it to survive. Follow this with a few examples, such as:

- Humans have fingers which enable them to make clothes to live in areas where they wouldn't be able to if they didn't have fingers.

- Hawks have very good eyesight which helps them to hunt from very high altitudes where the air currents make it easier for them to fly.
- Frogs can live on water or land which enables them to avoid predators.
- Cockroaches can run very fast considering their size, and can eat almost anything and live.
- Deer and rabbits have eyes on the sides of their heads which helps them to see predators coming from any side.
- Weevils that live in flour do not need to drink water.
- Cactuses can store water.

Adaptations allow organisms to survive in certain environments where other organisms cannot. For example, tomato plants can survive in environments that are too harsh for lettuce.

Cleanup. Discard the plants or let the students transplant them into empty milk cartons and take them home if they wish. Save whatever soil remains for later use. Rinse out the plastic inserts and store them. Save the chart for later use.

OPTIONAL ACTIVITIES

Will cold seeds develop? The same kind of experimental design will reveal whether lettuce and tomato will develop from seed when they are kept at various temperatures between 5°C and 22°C. Using picnic

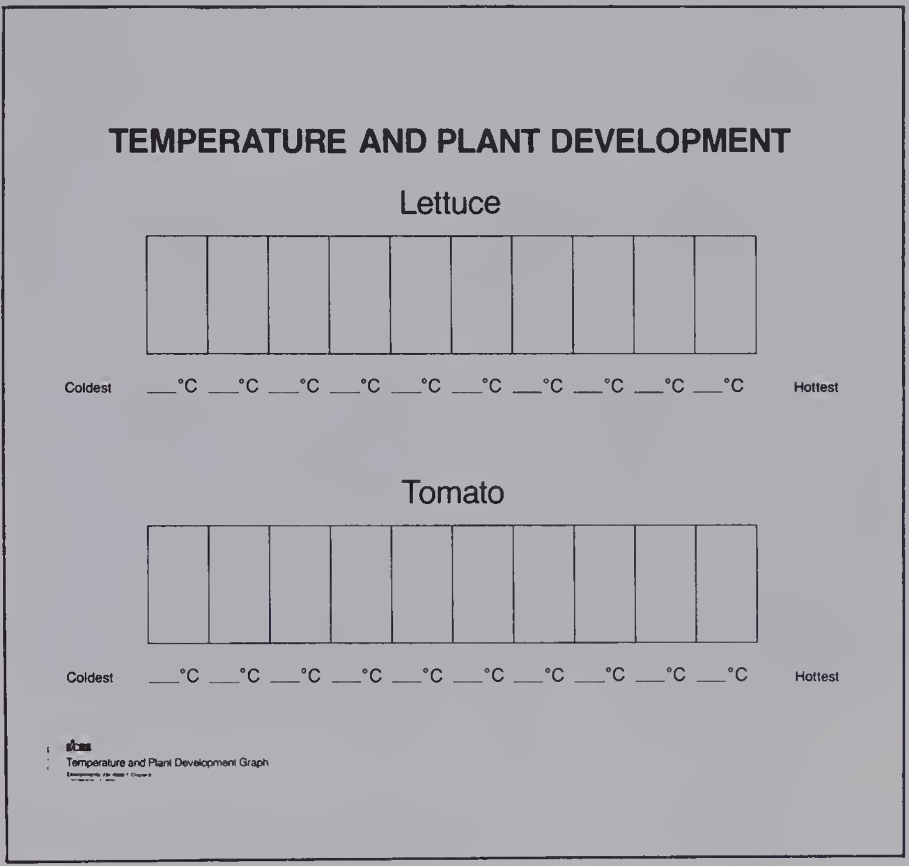
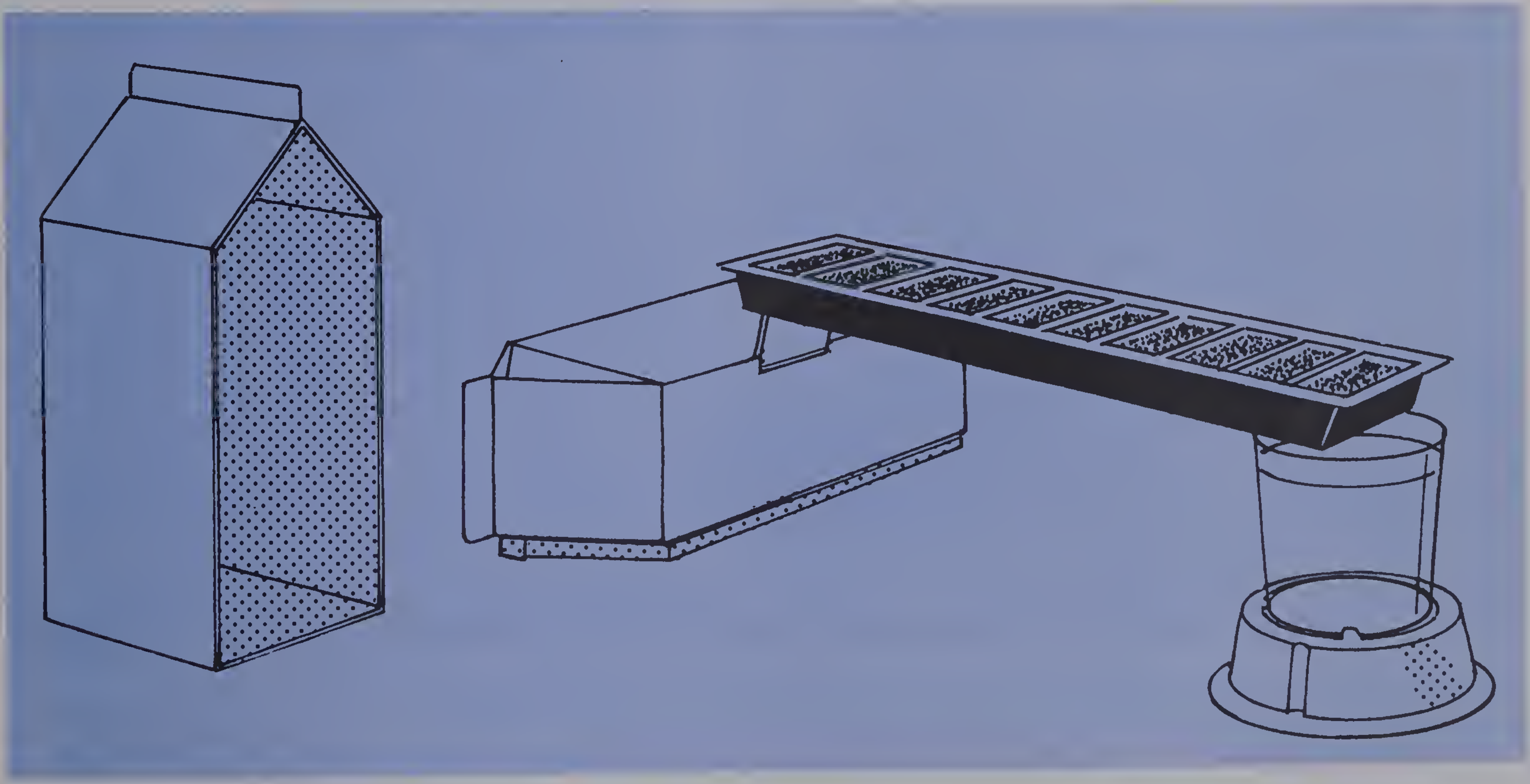

TEMPERATURE AND PLANT DEVELOPMENT
Lettuce
Coldest
___°C ___°C ___°C ___°C ___°C ___°C ___°C ___°C ___°C ___°C
Hottest
Tomato
Coldest
___°C ___°C ___°C ___°C ___°C ___°C ___°C ___°C ___°C ___°C
Hottest
Temperature and Plant Development Graph

Figure 8-8. Temperature and Plant Development chart

Figure 8-9. To test the effect of low temperature on seed development, use this setup. Remove a side from each of two cartons and nest them with ice inside. Lower the metal strap through a slot cut into the top carton.



type cold bags or half-gallon milk cartons containing ice, keep one end of the planter trough cold by inserting the metal strap into the ice. Allow the other end to remain at room temperature (about 22°C). The sections in between the two extremes will vary in temperature and can be measured with the thermometers.

Empty milk cartons, with the tops stapled closed and one side removed from each, can be nested together to provide some insulation for the ice or ice bags. Wrap the entire milk carton and trough ends with aluminum foil to eliminate air currents which will add heat to the ice.

Although you will have to remove water and add ice to this system every day for one week, the seeds near the ice will remain colder than those exposed to room temperature, even if you run out of ice overnight.

Seeds, plants, and temperature extremes. Some of your pupils may wish to compare a plant's responses to temperature at different stages of its life cycle. Comparing the effects of heat and cold on seeds and on growing plants may help children understand how some plants survive the extremes of seasonal fluctuations in temperature.

The procedure for this test involves exposing seeds and plants of the same kind (such as tomato) to temperature extremes and comparing their responses with those of seeds and plants at room temperature.

To provide high temperatures for one group of seeds and plants, you will need to arrange the light source so that is very close to the seeds and plants. Place about fifty tomato seeds in a vial. Keep a second set of containers of seeds and growing plants at room temperature and place the third set in a freezer compartment of a refrigerator. Include a thermometer in each system.

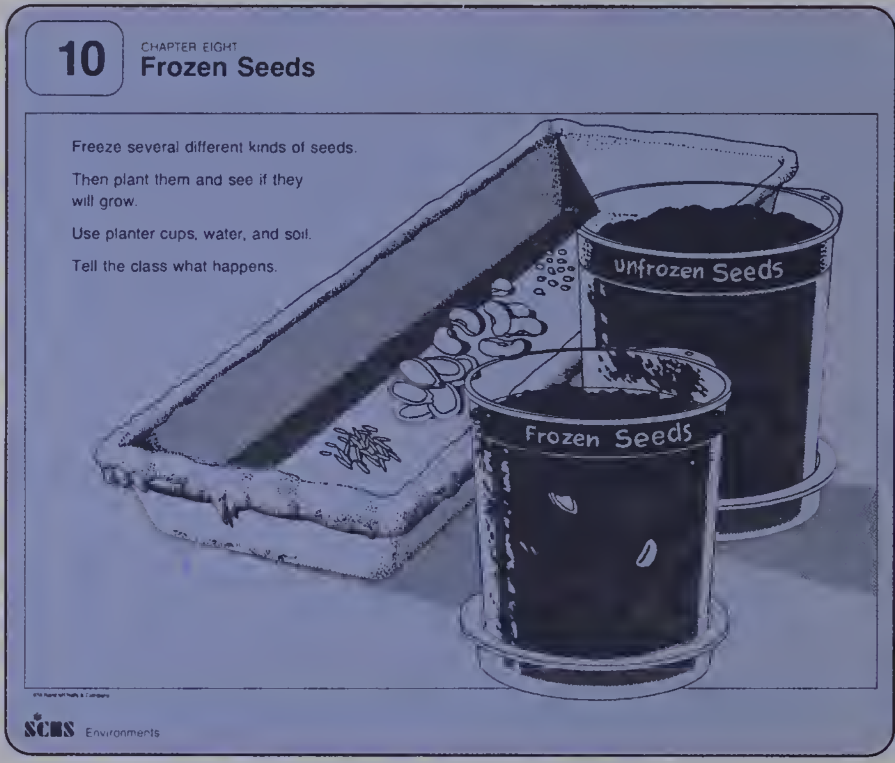
Maintain all three systems for about three days. Check them daily and water the growing plants so the soil remains moist. Then return the high and low sets of plants and seeds to room temperature. Plant all three groups of seeds in separate, labeled containers and maintain them at room temperature.

Have the children record and discuss any differences in the growth of the three seed groups as well as the responses made by the growing plants to the different temperatures. Help the children associate the information they derive from this activity with their records of the outdoor environment made in Chapters 5 and 6. You may wish to refer to the "Background Information" on page 37 before asking questions such as:

- Could the plants in this experiment survive a cold winter?
- Could the seeds in this experiment survive a cold winter?
- At what time of the year do most plants grow?
- When are seeds produced?
- How do plants survive from year to year if they only grow in the spring?

EXTENDING YOUR EXPERIENCE CARDS

10. Frozen Seeds. Children selecting this card will need four each of several different kinds of seeds, soil, and one or two planter cups. They will have to take the seeds home to freeze them, but the development test should probably be done at school. The card implies that the student plant unfrozen seeds of the same kind. A student who realizes the need for this control is to be commended.



10

CHAPTER EIGHT

Frozen Seeds

Freeze several different kinds of seeds.

Then plant them and see if they will grow.

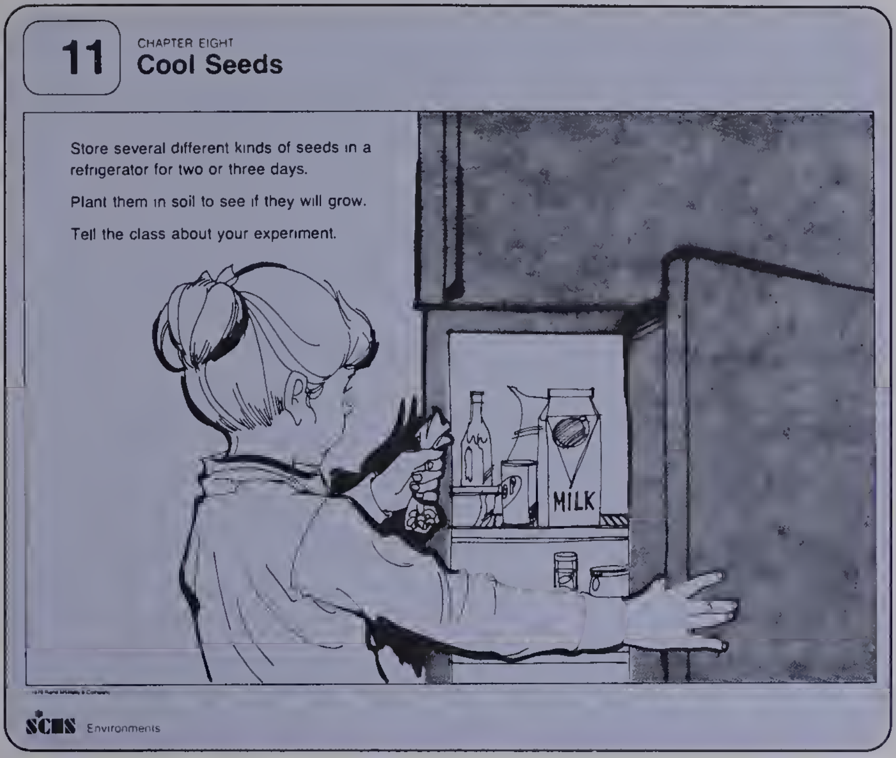
Use planter cups, water, and soil.

Tell the class what happens.

Unfrozen Seeds
Frozen Seeds

SCIS Environments

11. Cool Seeds. Students who select this card need the same materials as for card 10.



11

CHAPTER EIGHT

Cool Seeds

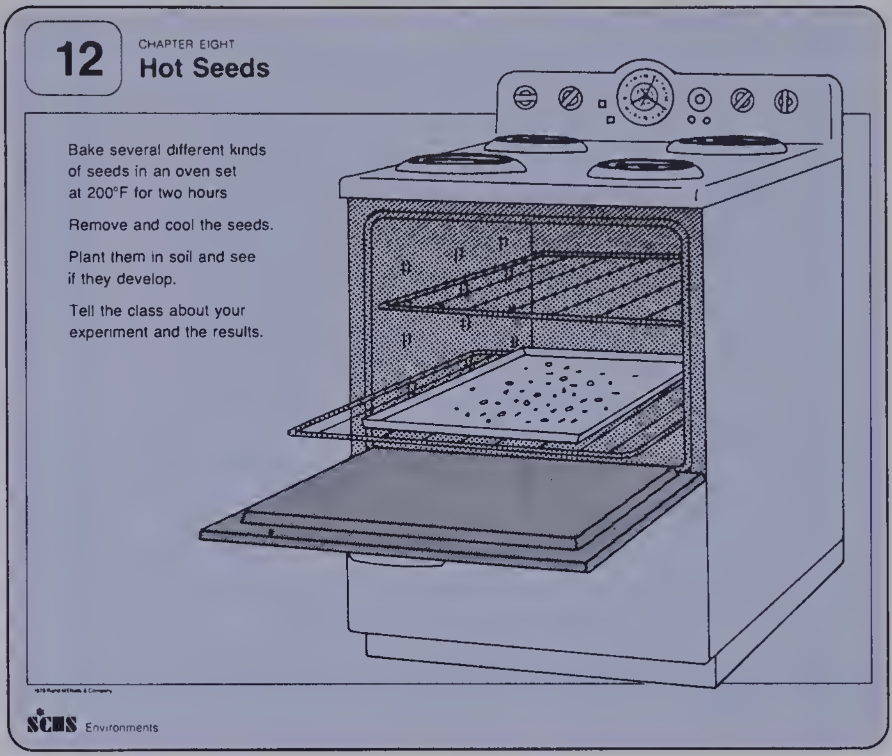
Store several different kinds of seeds in a refrigerator for two or three days.

Plant them in soil to see if they will grow.

Tell the class about your experiment.

SCIS Environments

12. Hot Seeds. Students using this card need the same materials as for cards 10 and 11.



12

CHAPTER EIGHT

Hot Seeds

Bake several different kinds
of seeds in an oven set
at 200°F for two hours

Remove and cool the seeds.

Plant them in soil and see
if they develop.

Tell the class about your
experiment and the results.

SCIS Environments

9

Plant Responses to Water

SYNOPSIS

Children experiment to determine the optimum amount of water for melon seed germination.

Suggested time: ***two class sessions one week apart***

TEACHING MATERIALS

For each child:

student manual page 15

For each team of two children:

crayon*

Drawer 2

plastic trough
2 trough inserts

Drawer 3

10 melon seeds
10 adhesive dots, red
5 labels
ruler

Drawer 4

tumbler
medicine dropper

For the class:

tape*
soil‡

Drawer 1

Evaluating Melon Growth in Water chart
Measuring Melon Growth in Water chart

* provided by the teacher
‡ Sand and Soil box

ADVANCE PREPARATION

Set out the teams' materials at distribution stations.

Remove the metal straps from each trough by pulling them straight out. Holding the strap in one hand and the opposite end of the plastic trough in the other hand is the easiest way to remove the straps.

TEACHING SUGGESTIONS

This activity is an invention of *range* and exploratory for the concept of *optimum*.

As you introduce this experiment, relate it to the water-related events the children have observed during their experiences with organism responses and the environmental changes outside.

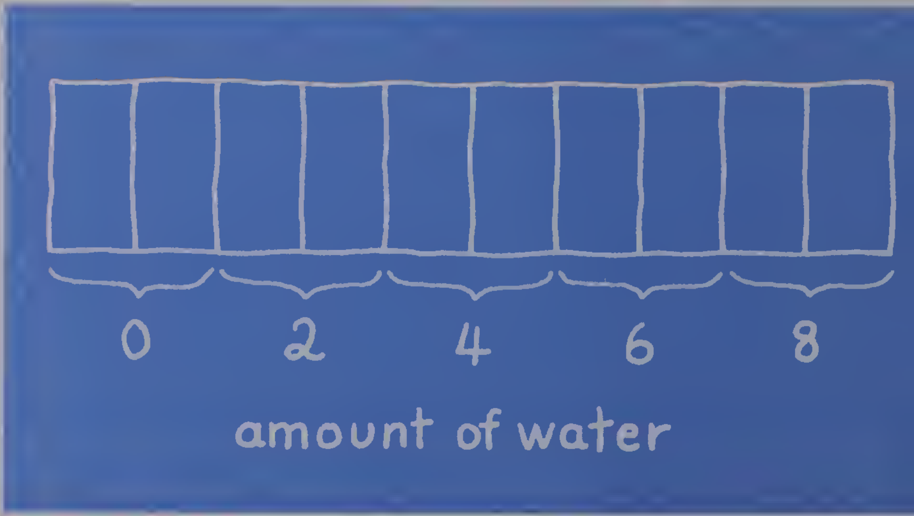
They all know seeds need water to develop, but they probably do not know how much. Many people have had difficulty determining how much water to provide for seeds and plants. This experiment shows how to find out what amount of moisture is best.

Investigating the importance of water. Ask the students how they could determine the amount of water best for developing melon seeds (or any other kind of seed, for that matter). Some will have no idea, but others may suggest trying to grow seeds in different amounts of water and seeing which amount is best. Follow up on that idea and suggest to the students that they use the trough inserts as planters. If the students don't mention how they would vary the amounts of water for the different seeds, ask them how much water they would use for the first seed, the second seed, etc.

A rough diagram of the experimental setup drawn on the chalkboard as the children develop the experimental design has proved very helpful to children in trial groups. One such design is shown in Figure 9-1.

If the children are not yet ready to design an exper-

Figure 9–1. Illustrating the experimental setup as children plan it.



iment, suggest the following design for each team of three. Each team will get one trough, two inserts, ten melon seeds, a tumbler, and a medicine dropper.

- Fill each section of one insert with soil.
- Plant one seed in each section.
- Using a colored crayon, label the lip or side of each section with the number of dropperfuls of water that go into that section. Also label the planter with the team name and the date. The tumblers, when half-filled with water, become the source of water for each team.
- The first and second sections get no water.
- The third and fourth each get two dropperfuls.
- The fifth and sixth sections each get four dropperfuls of water.
- And so on.

Have each group invert the second insert over the first and tape them together. They should place their planters in light, but away from direct sunlight and excessive heat. Your students should inspect the seeds after three or four days for evidence of growth. No more water should be added to any of the experimental setups.

Recording the data. About one week after setting up the experiment, the children should make a final observation and record the results. Two techniques for recording data are described below. By using both recording methods, students will be able to compare their relative merits.

Evaluating growth. Ask the children to assign a numerical value to the amount of growth with each amount of water. The amount producing the most melon growth would be given a value of 5; that with the next highest melon growth a value of 4, and so on.

Display the chart Evaluating Melon Growth in Water. Label the horizontal axis with the different amounts of water the children used. Then give each team five dots. To record melon growth, a child places a dot in the column above the amount of water used and opposite the numerical value of growth. This procedure should be carried out for each team's results.

Discussion. Encourage the children to discuss the growth of their melons, the tallest melon, which ones did not develop, which ones grew slowly, what effects too little or too much water had, how much water was just right, etc.

Some of the children may have noticed that when their seeds were completely covered with water, they usually did not develop. The children may correctly infer from such evidence that seeds need to "breathe."

"Inventing" range. With the chart entitled Evaluating Melon Growth in Water posted at the front of the classroom, point to the first column indicating that no water was used. Write the numeral "0" on the chalkboard to the side of the chart. Sweep your hand down the far right column and ask the students what the greatest amount of water was. When they say 8 or whatever large number they may have used, write that number of units on the chalkboard to the right of the zero. Pointing to the two extreme numbers—0 and 8—tell the children that this difference between the smallest and largest amounts of water is called the *range*. It represents the greatest difference between the extremes or ends of any scale.

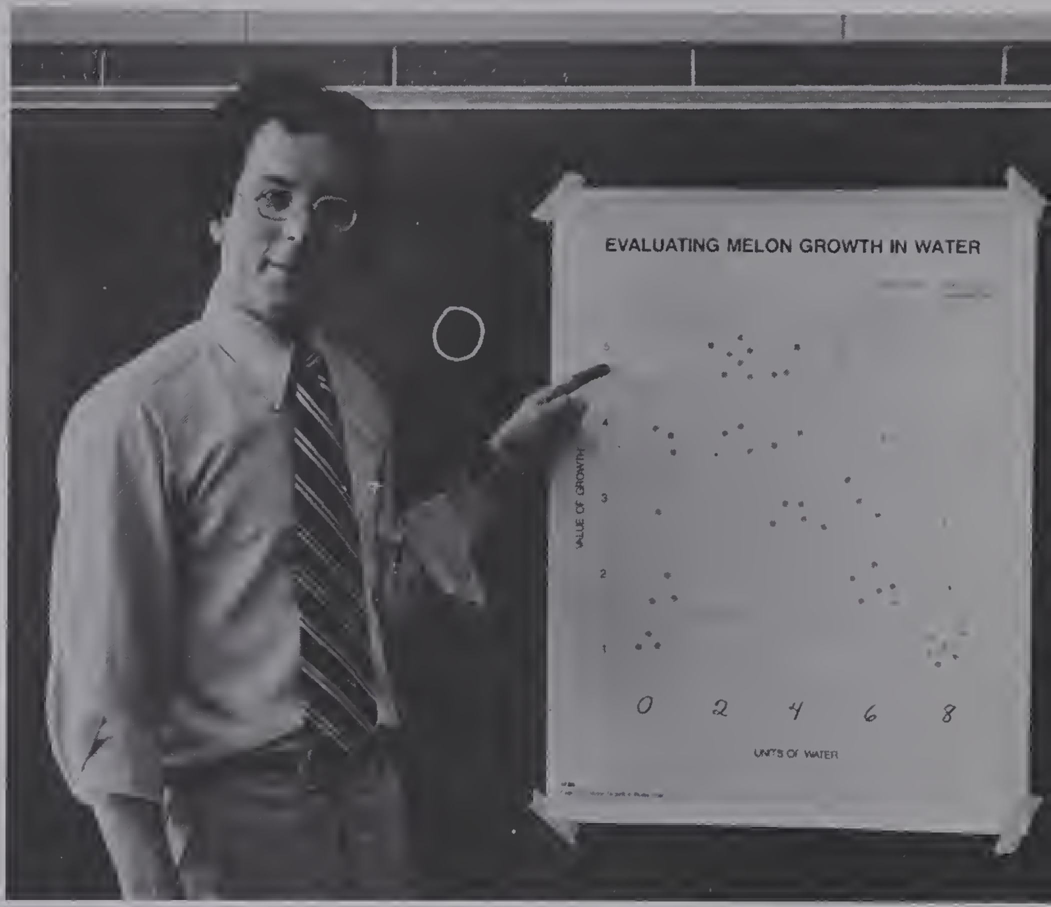


Figure 9-2. Inventing the concept *range*.

Reinforce that term by selecting several other examples from the classroom. Some possibilities are: largest and smallest chalk lengths, tallest and shortest melon plants in the room, the longest and shortest bus routes of the students, and the widest and narrowest openings of the curtains. Each of these examples represents a range of length, height, or time.

Measuring growth. The children can also record melon growth by plotting the length of the seedlings on a grid. Display the Measuring Melon Growth in Water chart. Label the horizontal axis as you did for the previous chart. Give each team a ruler and five dots. Have the children measure the length of the tallest plant in each section and place a dot on the line showing the amount of water used and opposite the length in millimeters.

You might invite the students to tell you the range of melon growth as indicated by the Measuring Melon

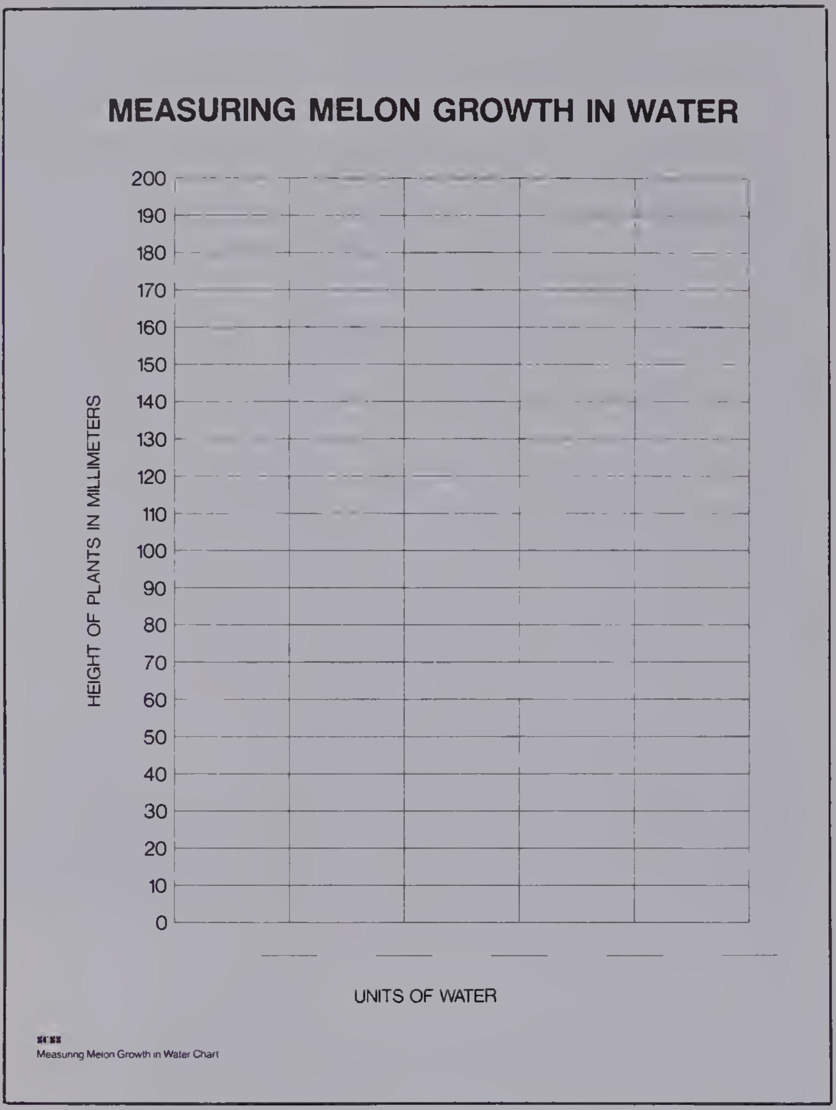


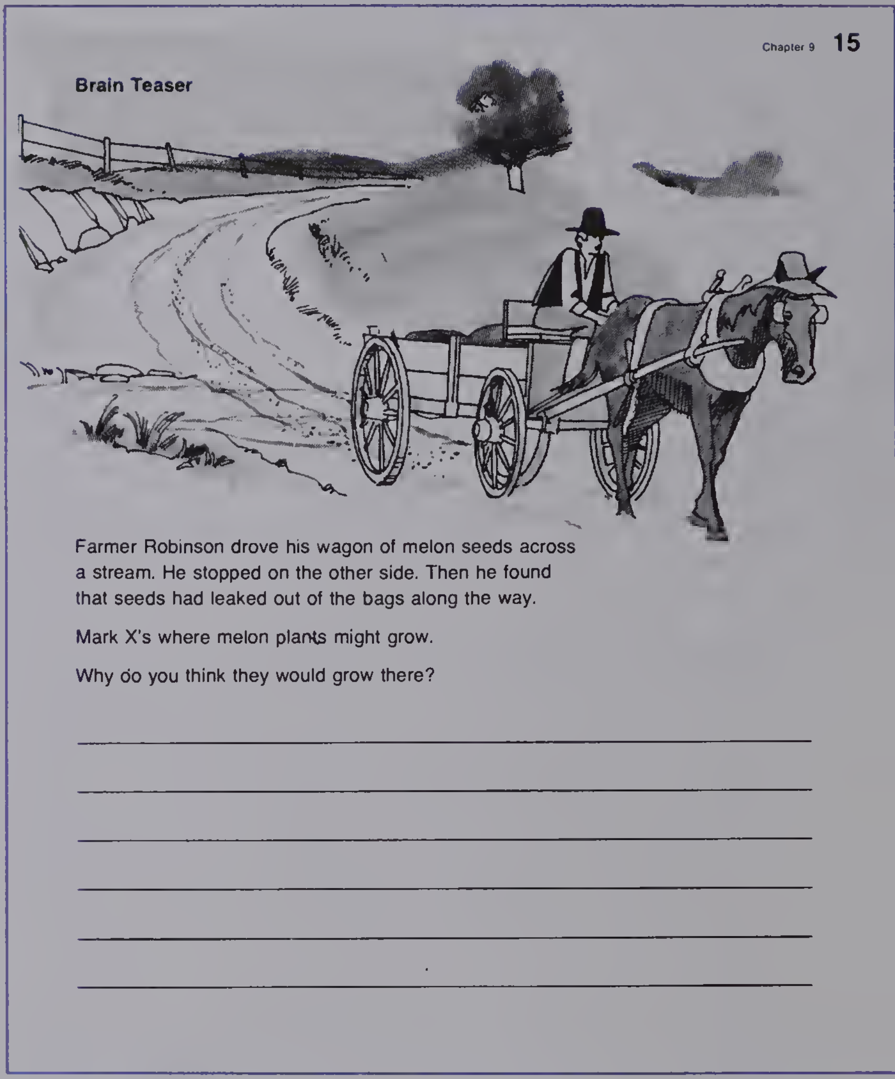
Figure 9–3. The Measuring Melon Growth in Water chart.

Growth in Water chart. If not, they could show you the range of plant growth by displaying the tallest melon plant and the smallest plant or seed that did not sprout. During the remainder of this unit, try to use the word range wherever appropriate. The term *optimum* will be introduced later.

Two ways to record data. Post the two completed charts for the children to see. Inquire of the students which chart best helps them to determine the range; also which chart best displays the height of the plants; and which chart best indicates the amount of water that is best for melon development.

By considering the two methods of recording, the children should begin to realize that data from an experiment can be handled differently.

Using student manual page 15. You may have the students ponder and complete this page any time after the conclusion of the data analysis. We would expect children to suggest that the farmer's seeds would develop and grow in the same places their seeds grew. Usually, that would be at the edge of the stream rather than in either the middle or on the road, but a child who suggests that the melons will develop in the stream is also correct if he obtained the same kind of results from his experiment. Decisions based upon evidence are more valuable than those based upon hearsay and should not be scoffed at because they do not agree with everyone else's.


Chapter 9 15

Brain Teaser

Farmer Robinson drove his wagon of melon seeds across a stream. He stopped on the other side. Then he found that seeds had leaked out of the bags along the way.

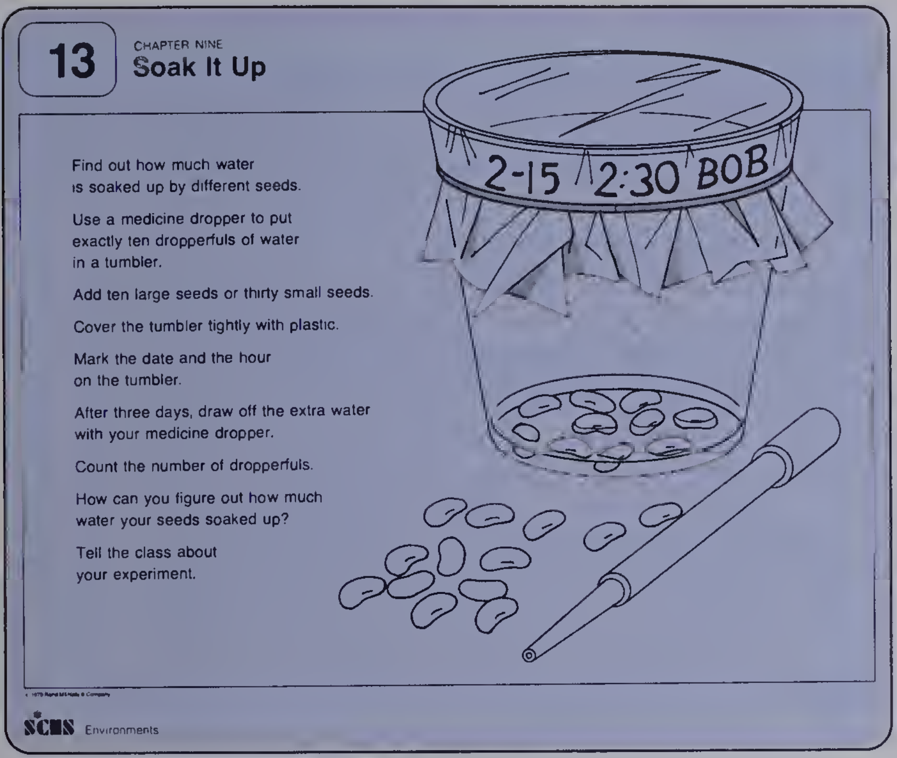
Mark X's where melon plants might grow.

Why do you think they would grow there?

Cleanup. Rinse out (using no soap or detergents) the planters after rubbing the labels off with a dry paper towel. Store the air-dried planters for future use. Remove and save the charts. The data may be needed in Chapter 16, so don't erase it until you store the charts at the end of the unit.

EXTENDING YOUR EXPERIENCE CARDS

13. Soak It Up. A student selecting this card will have to be given ten to thirty of each kind of seed in the kit (excluding melon) or allowed to collect a variety of seeds from a weedy area. Also provide a container to be used as a planter, a plastic bag or wrap, and a medicine dropper.



13 CHAPTER NINE **Soak It Up**

Find out how much water is soaked up by different seeds.

Use a medicine dropper to put exactly ten dropperfuls of water in a tumbler.

Add ten large seeds or thirty small seeds.

Cover the tumbler tightly with plastic.

Mark the date and the hour on the tumbler.

After three days, draw off the extra water with your medicine dropper.

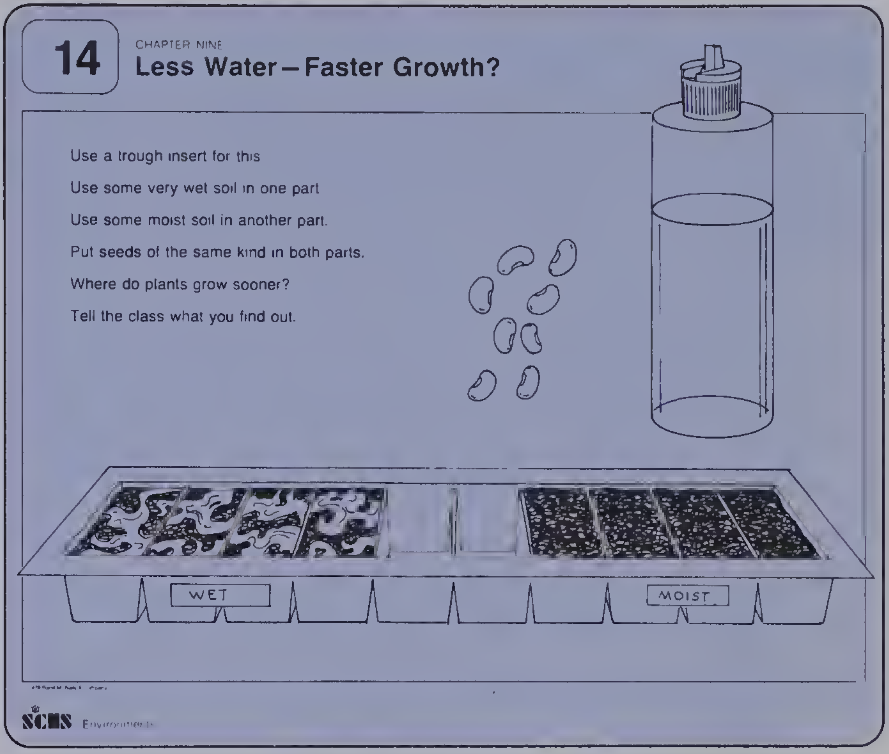
Count the number of dropperfuls.

How can you figure out how much water your seeds soaked up?

Tell the class about your experiment.

SCIIS Environments

14. Less Water—Faster Growth? Children selecting this card will need to borrow a planter tray, soil, and several different kinds of seeds from the kit (excluding melon). A colored crayon and a medicine dropper also are needed. The experiment will take about ten days.



14 CHAPTER NINE **Less Water—Faster Growth?**

Use a trough insert for this.

Use some very wet soil in one part.

Use some moist soil in another part.

Put seeds of the same kind in both parts.

Where do plants grow sooner?

Tell the class what you find out.

SCIIS Environments

10

Plant Responses to Chemicals

SYNOPSIS

Children design and carry out an experiment to determine how germinating melon seeds respond to varying concentrations of fertilizer and salt.

Suggested time: ***one day to set up, an intervening period of one weekend, and one-half session for evaluating the results***

TEACHING MATERIALS

For each child:

student manual page 16

For each team of two children:

crayon*

Drawer 2

plastic trough
trough insert

Drawer 3

10 melon seeds
ruler

Drawer 4

tumbler
medicine dropper

For the class:

teaspoon*
tape*
soil‡

Drawer 1

chart paper

Drawer 4

tumbler

Drawer 5

fertilizer

* provided by the teacher
‡ Sand and Soil box

ADVANCE PREPARATION

Place about two level teaspoons of the fertilizer in a tumbler and add a little water. Stir until the fertilizer is dissolved and add enough water to nearly fill the container. Add some of this solution to each of the sixteen tumblers. If the students need more solution later, make a second batch. Establish three distribution stations with some of all the materials at each station.

TEACHING SUGGESTIONS

Here the discovery phase of the concept of *range* begins. In addition, you "invent" the idea of *optimum* and *controlled experiment.*

Remind the children that they have now seen that light, temperature, and water all affect plants. Tell them that plants also respond to another environmental factor—chemicals. Show the students the fertilizer water you made up and ask them how they could find out how melon seeds respond to this.

Planning the experiment. Some children will suggest "trying it." Ask them how they would go about trying it, and encourage them to describe how many melon seeds they would use, how much fertilizer water they would use, what containers they would use for the seeds, etc. If a child suggests putting two seeds into each one of the sections of the trough inserts and adding enough fertilizer water to cover the seeds, recall what happened when they used that much water in the Chapter 9 experiment. A quick review of the data recorded on the class chart will remind the students that they will not get any growth if they cover the seeds with fluid. On the other hand, each seed must be wet enough for germination to begin.

If no child has raised the question about how to make all the water levels the same when you have to add different amounts of fertilizer water to each section, bring it up. Adding eight drops of fertilizer water is not going to change the level much, but it should be considered. The experiment will not be controlled if the sections have not only different amounts of fertilizer, but different total amounts of fluid also. Such an experimental design would be very poor, because we wouldn't know whether the results were caused by differences in amounts of water or in amounts of fertilizer.

"Inventing" ***experimental control.*** Introduce the concept of a *controlled experiment* by telling the students that in a controlled experiment only one variable—such as the amount of fertilizer—can be tested at one time. Every other part of the experiment has to be the same in order for it to be a "fair" test.

Considerations that will make this test fair are:

- *Same* number of melon seeds in each section.
- *Same* amount of total fluid in each section.
- All sections stored at the *same* temperature.
- All sections stored in the *same* light.
- All sections stored in the *same* amount of air movement.
- Only the amount of fertilizer *different* from section to section. One section with no fertilizer.

If you have not already done so, sketch the experimental design on the chalkboard. Have the children select a place where the troughs can be stored, keeping the above considerations in mind.

Experimenting. When you think the children have a good idea of a controlled experiment and of just what they are going to do, let them begin. Have them pick up their equipment at the distribution stations and set up the experiment, using the medicine droppers for putting drops of fertilizer water onto the seeds. As the children work, visit each of the groups and give them help if necessary.

After all the children have completed setting up the experiment, have them store their experiments in the place agreed upon earlier. Allow them some time every other day or so to look at the seeds. Water may be added, but if so, equal amounts must be added to each division.

Recording the results. About one week after planting, encourage the children to examine the development of the melon seeds for the last time.

Have the class decide on a technique for recording the data. Either the evaluating or measuring technique (see page 47) is suitable. When a recording technique has been selected, the chart paper should be filled in and the data recorded on it.

"Inventing" ***optimum.*** After the data have been added to the chart, ask the children what amount of fertilizer is best for melon growth. Encourage the selection of the fertilizer amount in which most of the melons grew. Tell the children this amount of fertilizer water is called the *optimum*.

Ask the children if the information they got from this experiment makes it possible for them to determine the best amount of fertilizer concentrations for growth of all melon seeds in any soil. After allowing them to speculate about the data, ask how more definite data could be obtained. Would additional experiments be necessary? If so, what kind? If you have time and think that the students would benefit from further opportunities to improve their understanding of a controlled experiment, encourage them to try an additional experiment.

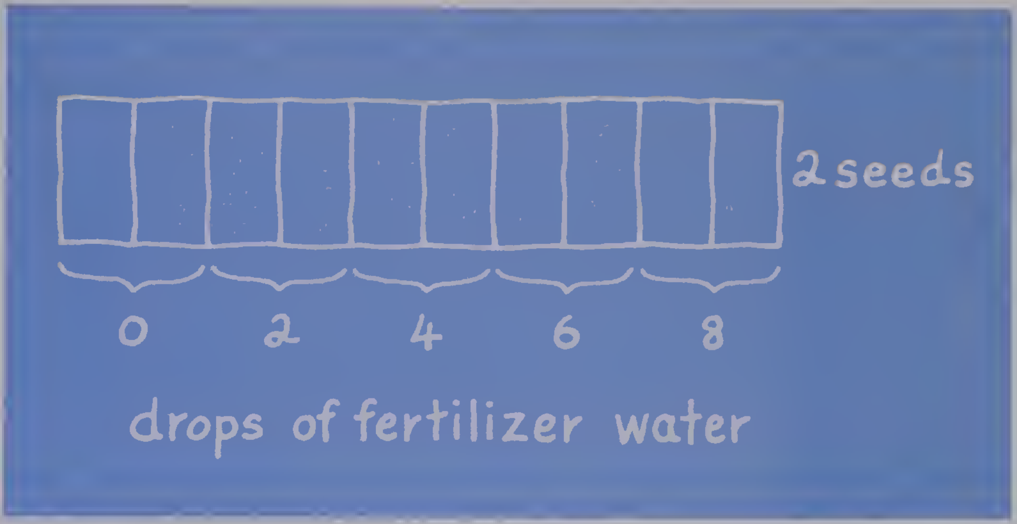
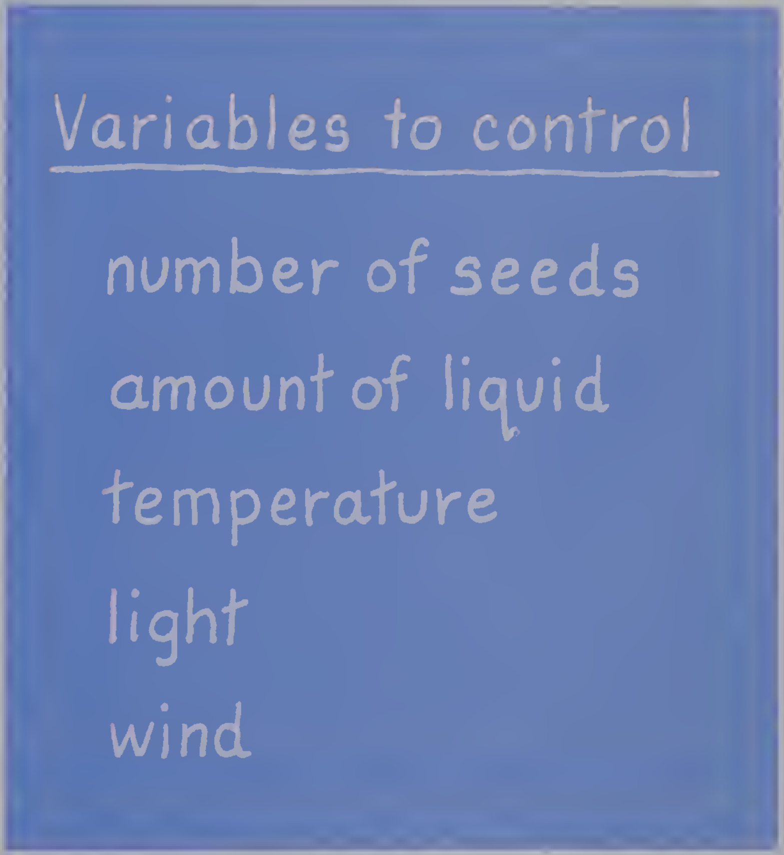


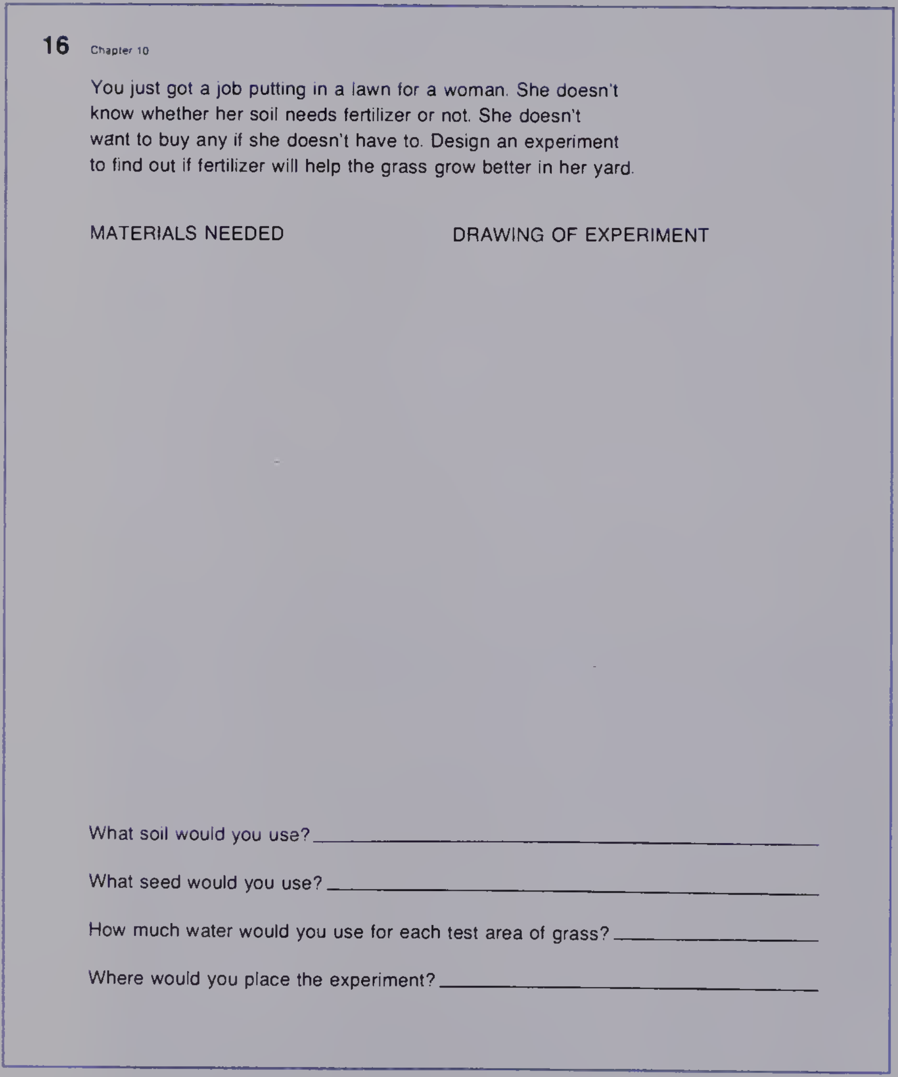
Figure 10–1. Helping the children plan the experiment.

Figure 10-2. Making sure that the experiment is controlled.



Using student manual page 16. Encourage your students to complete this student manual page. It will help them to think the problem through and to organize their thoughts. By holding a class discussion of their suggested experiments, you will be able to see how well the children understand a controlled experiment. Children who don't feel it is necessary to keep all of the test sections together, use the same seed the woman has, use soil from the woman's yard, and keep all other variables the same except for the fertilizer, do not fully understand experimental control.

Cleanup. When the children have finished their experiments, have them discard the contents of their trough inserts and tumblers. Rinse and return them to the kit for future use. Save the chart.



16 Chapter 10

You just got a job putting in a lawn for a woman. She doesn't know whether her soil needs fertilizer or not. She doesn't want to buy any if she doesn't have to. Design an experiment to find out if fertilizer will help the grass grow better in her yard.

MATERIALS NEEDED

DRAWING OF EXPERIMENT

What soil would you use? ____________________

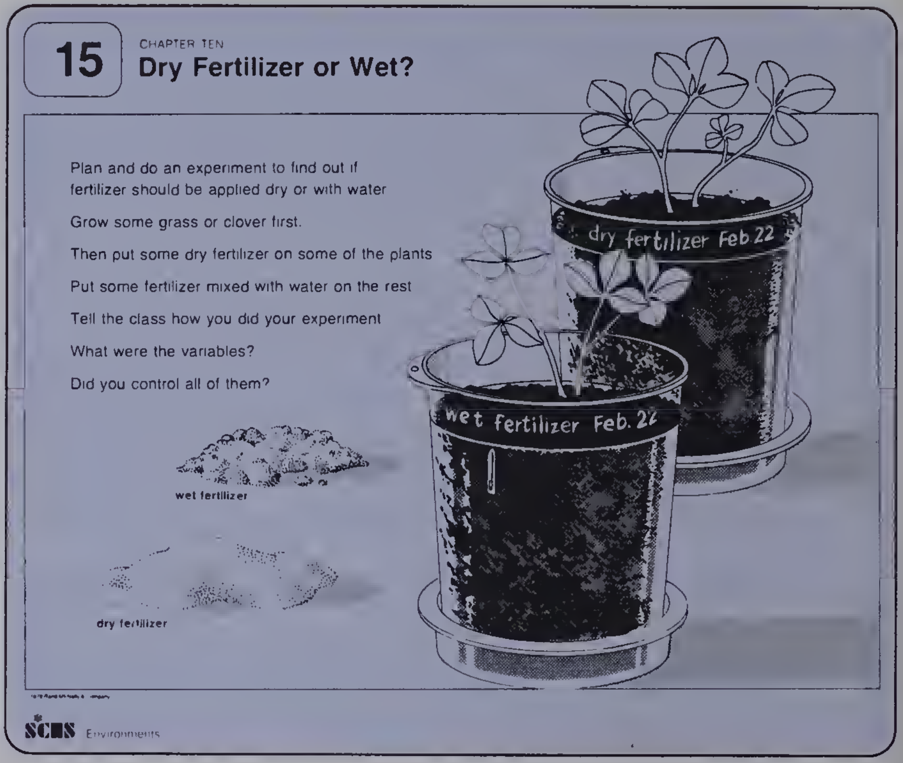
What seed would you use? ____________________

How much water would you use for each test area of grass? ____________________

Where would you place the experiment? ____________________

EXTENDING YOUR EXPERIENCE CARDS

15. Dry Fertilizer or Wet? A child selecting this card will need to grow two containers full of clover or grass. The trough inserts or any other containers can be used. The child will also need fertilizer, soil, and a medicine dropper.



15 CHAPTER TEN

Dry Fertilizer or Wet?

Plan and do an experiment to find out if fertilizer should be applied dry or with water

Grow some grass or clover first.

Then put some dry fertilizer on some of the plants

Put some fertilizer mixed with water on the rest

Tell the class how you did your experiment

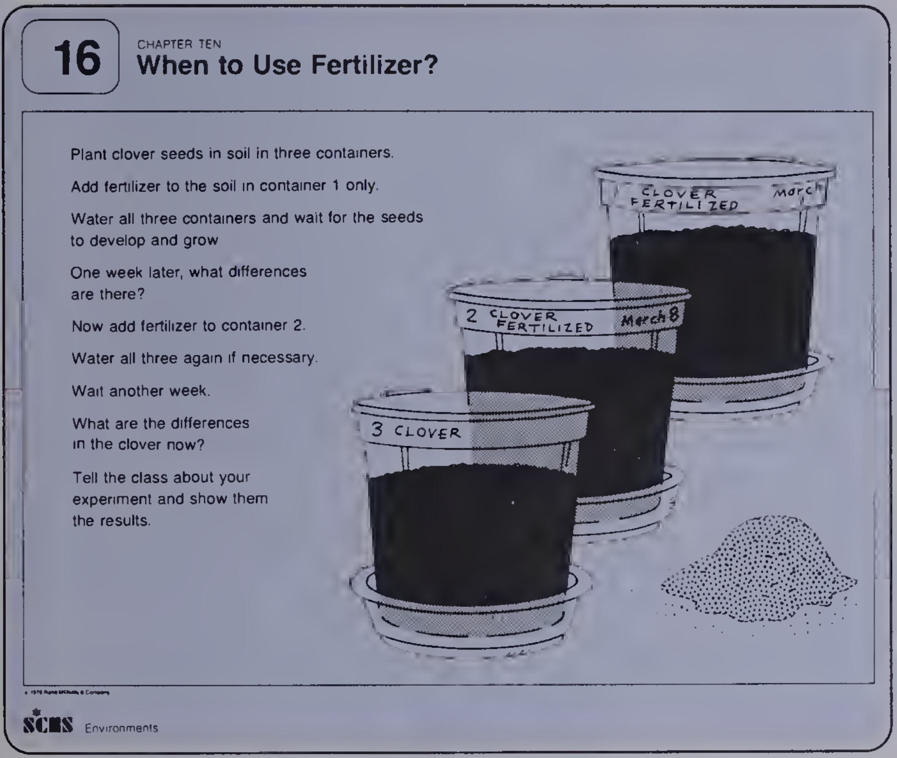
What were the variables?

Did you control all of them?

SCIIS Environments

16. When to Use Fertilizer? The student selecting this card will need ten to twenty clover seeds, three containers or a trough insert, soil, fertilizer, and a water sprinkler.

If your students are interested, allow them to design and carry out the additional experiments they suggest. For example, they may suggest letting the melons grow for a longer time before recording the growth, or they may wish to plant new seeds and add fertilizer after seedlings have appeared.



16

CHAPTER TEN

When to Use Fertilizer?

Plant clover seeds in soil in three containers.

Add fertilizer to the soil in container 1 only.

Water all three containers and wait for the seeds to develop and grow

One week later, what differences are there?

Now add fertilizer to container 2.

Water all three again if necessary.

Wait another week.

What are the differences in the clover now?

Tell the class about your experiment and show them the results.

SCIS Environments

Extending Your Experience cards 1–16 are now available for the children's use. For materials needed, refer to the equipment list accompanying the set of cards.

CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's understanding of the relationship between environmental factors and plant growth, turn to page 98 of the evaluation section at the back of the guide.

Part Four

Animal Responses to Environmental Factors

OBJECTIVES

To experimentally determine the optimum levels of several environmental factors for three kinds of animals.

On the basis of previously learned information, to prepare a terrarium with a suitable environment for the development and growth of plants.

BACKGROUND INFORMATION

Animals, unlike plants, can move from poor environments to better ones. Because of competition from other animals, many live on the edges of good environments, only making forays into these areas for their food and water. As temperatures, moisture levels, light and wind conditions change during the course of a day, animals continually readjust, usually by moving from one place to another. The movements may be only a matter of millimeters for isopods, but more than a mile for cattle and deer.

Nearly all animals make daily readjustments to achieve the optimum level of at least one environmental factor. What humans would call sacrifices and trade-offs are made by animals too, just as we humans make. Regardless, but not oblivious, of the temperature, hungry animals conditioned to find their food in a certain area at a certain time will temporarily venture into unfavorable areas to take advantage of the availability of food at a particular time. Like humans, other animals will sacrifice comfort for such vital environmental factors as water and food.

Most animals will select a spot with favorable conditions over those where the conditions are unfavorable. They respond to changes in the intensity of a factor by moving randomly until they find an area in which most factors are present in optimum amounts. This kind of animal movement is often seen in deserts, where the daily temperature range can be great. For example, in the cool early morning, lizards move to rocks warmed by the sun; later in the day, they burrow deep under the sand, thus avoiding the high surface temperature. This type of behavior enables an animal to survive in areas in which the range of intensity of certain environmental factors far exceeds its limits of survival.

The yearly fluctuations in temperature, light, moisture, chemicals, and food are excessive in many parts of the world. Migrations as great as 5,000 miles are made by some birds. There is no reason to think the birds understand why they make these long flights—scientists certainly do not think these birds "decide," in the human sense of the term, that they should begin their flight in order to survive. The birds that migrated in the past simply survived and reproduced while others died or were unable to reproduce. The result of this adaptation, called migrating, is that animals do move from areas of poor environmental conditions to areas better able to support their existence during the extreme changes brought about by each revolution of the earth about the sun.

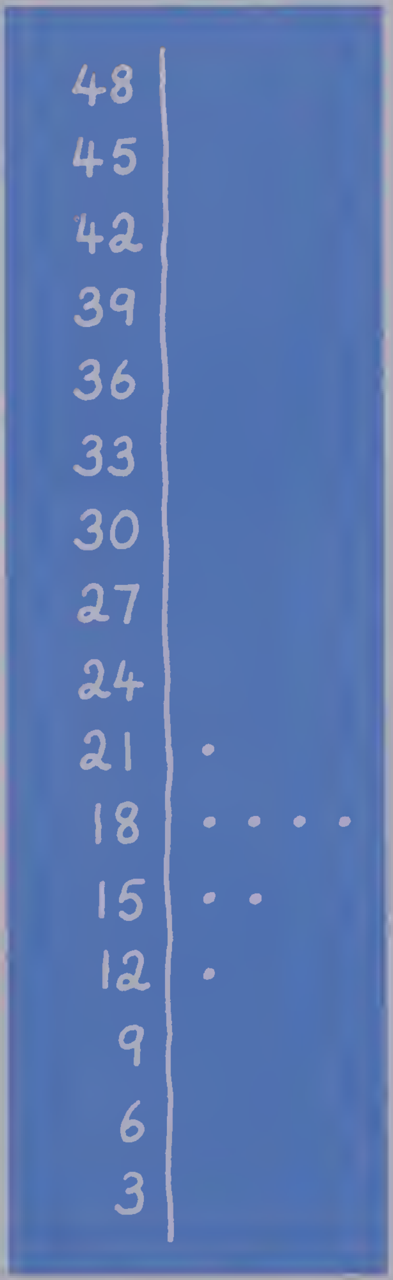
Children's experiments. The activities in Part Four contain experiments designed to help your students determine animal responses to environmental factors. They will discover that different organisms respond in diverse ways to varying intensities of environmental factors.

Histograms. In the physical science unit *Subsystems and Variables,* histograms are introduced as an effective technique for children to record experimental results. The children will use the same technique for recording results in *Environments.*

One might expect organisms of the same kind to respond identically when exposed to identical conditions. In reality, some variation always exists between any two individuals. A histogram can show the extent of this variation as well as the frequency with which a particular response was observed.

Imagine that your pupils are testing the responses of isopods to a wide temperature range. In the experiment, the children determine the optimum range for isopods. Each child places his isopod in a container in which temperatures range from a minimum of 3°C at one end to a maximum of 48°C at the opposite end. After a predetermined time, say five minutes, the children record the positions of their isopods. The first eight children might report temperatures of 12°, 18°, 15°, 18°, 21°, 18°, 18°, and 15°C.

Figure IV–1. A vertical histogram.



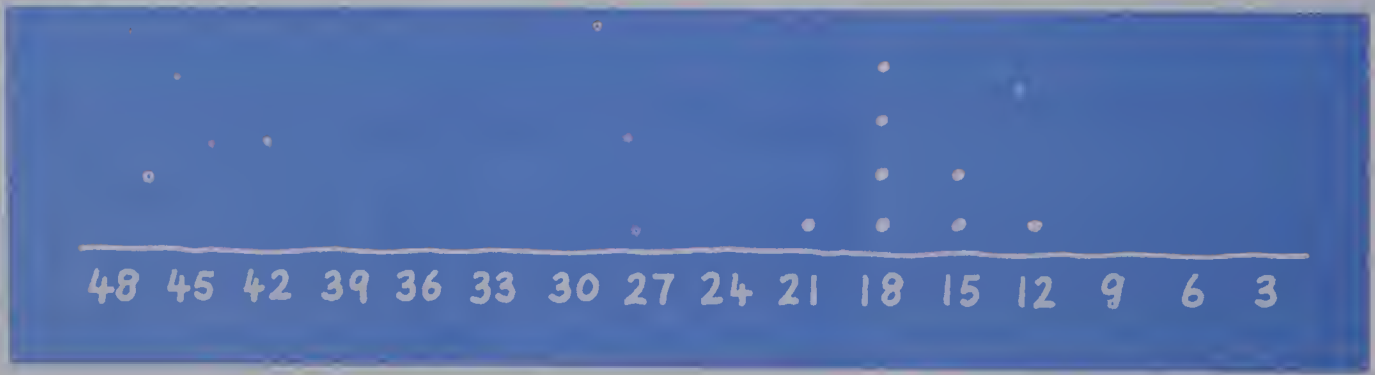
To make a histogram from this experimental data, you construct a number line to represent the temperatures in the range. The number line may be drawn vertically or horizontally depending on available space and on which method seems to better display the data. Each child places a dot beside or above the numerical value to indicate the result he obtained. The results in our example are shown on both vertical and horizontal histograms. Both histograms show that the temperatures range from 3° to 48°C and that one isopod came to rest at 12°, two at 15°, four at 18°, one at 21°, and none at any other temperature.

Using the definitions of range and optimum, you would say the temperature range was 3° to 48°C and the optimum part of the range for isopods was 12° to 21°C.

OVERVIEW

In Chapter 11, "A Place to Live In," the children prepare terrariums by planting seeds under optimum environmental conditions according to what they have learned so far in this unit. Isopods arrive and the children investigate the response of these animals to various temperatures in Chapter 12, "Temperature and Isopods." Children use their previously learned mathematical and graphing skills to chart the behavior of the isopods. In Chapter 13, "The Best Environment for Isopods," the students extend their knowledge and gain new skills in planning and carrying out experiments to determine the responses of isopods to environmental factors of light and moisture. In Chapter 14, "The Environment of Land Hermit Crabs," your pupils introduce new animals, hermit crabs, into their terrariums and experiment to determine the responses of these animals to light, moisture, and temperature. As in earlier activities, the children record, graph, and interpret the results of their own experiments. The concept of variation is introduced. In Chapter 15, "The Environment of Beetles," beetles are added to the children's terrariums, and these animals are tested to determine their responses to light, temperature, and moisture.

Figure IV–2. A horizontal histogram of the same data.



11

A Place to Live In

SYNOPSIS

Children plant seeds according to the results of their previous experiments with plants as preparation for adding three kinds of animals.

Suggested time: ***one class session for planting, followed by about one-half session for adding the animals***

TEACHING MATERIALS

For each child:

student manual page 17

For each team of four children:

small water dish for terrarium*

Drawer 3

4–10 sunflower seeds
4–10 tomato seeds
4–10 lettuce seeds
wooden stick

Drawer 4

six-liter container
container lid

For the class:

4 lettuce leaves*
100 isopods†
75 beetles†
20 land hermit crabs†
80 isopods†
soil‡

Drawer 4

4 water sprinklers

Drawer 5

fertilizer
6 planter cups

* provided by the teacher
† in Shipment EN-1
‡ Sand and Soil box

ADVANCE PREPARATION

Set up three distribution stations to facilitate the distribution of the materials. Place materials for about ten children at each station. Getting the soil will be the most time-consuming part of this distribution, so provide three distribution containers and six planter cups as scoops.

TEACHING SUGGESTIONS

In this chapter, you "invent" *environment.*

Planning the terrariums. Tell the students that they will soon be getting some animals and that the animals will need a habitat (place to live). Mention that the animals eat plants and suggest that the children grow some plants before the animals arrive.

Show the children a 6-liter plastic container and suggest that they add soil and plant different kinds of seeds in it for the arriving animals. Tell them they may plant the seeds any way they like, but they should consider the plants' needs for the environmental factors of light, temperature, water, and chemicals.

Divide the class into teams of four children and let them begin. An environmental variable not yet dealt with in this unit is that of seed-planting depth. Some children may ask you what the "right" depth for each of the seeds is. You may suggest that they do another experiment, such as the one described in Extending Your Experience card 17, or tell them to push the seed

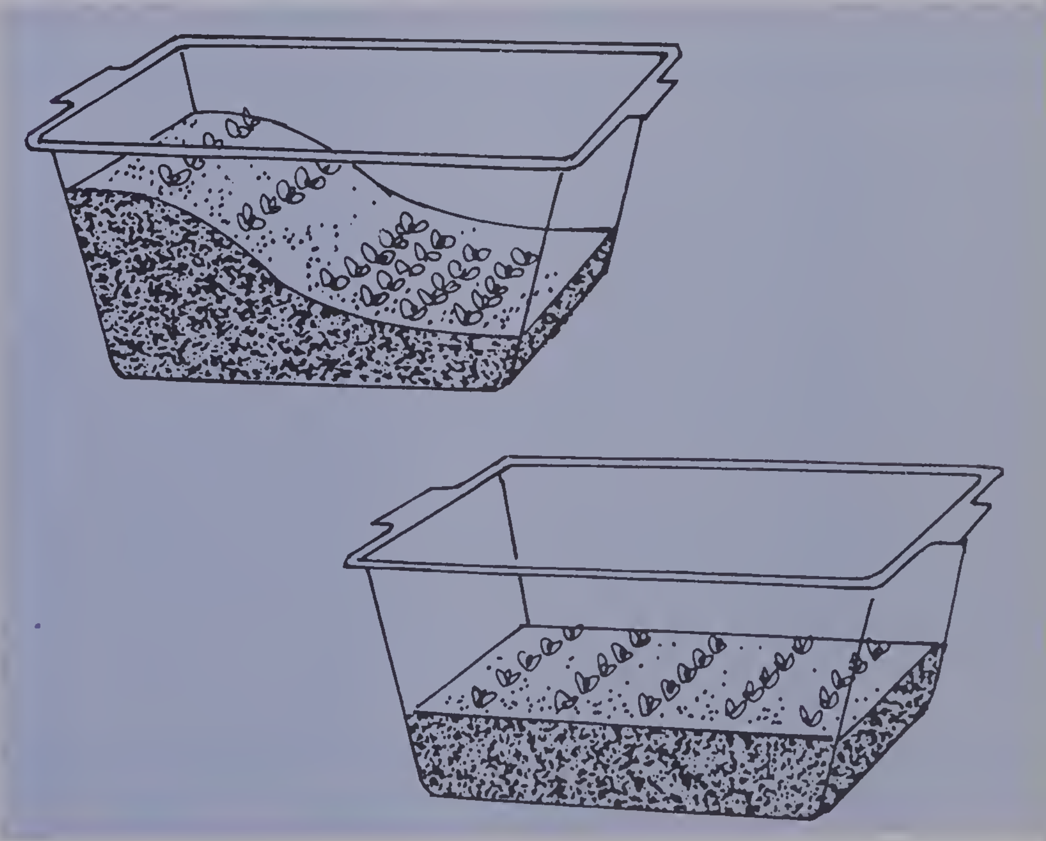


Figure 11–1. Children may plant their terrariums in different ways.

into the soil to a depth of about 1 centimeter (about the depth of their baby fingernail). Visit the groups as they are establishing their terrariums and let them show you how they are arranging their seeds.

If a team seems to be heading for disaster because they have placed all their seeds at the container bottom, flooded the container, or fertilized too much, let them continue without warning them. There will be opportunities for them to discover what they might have done wrong and to replant. Solving these real problems is a worthwhile experience.

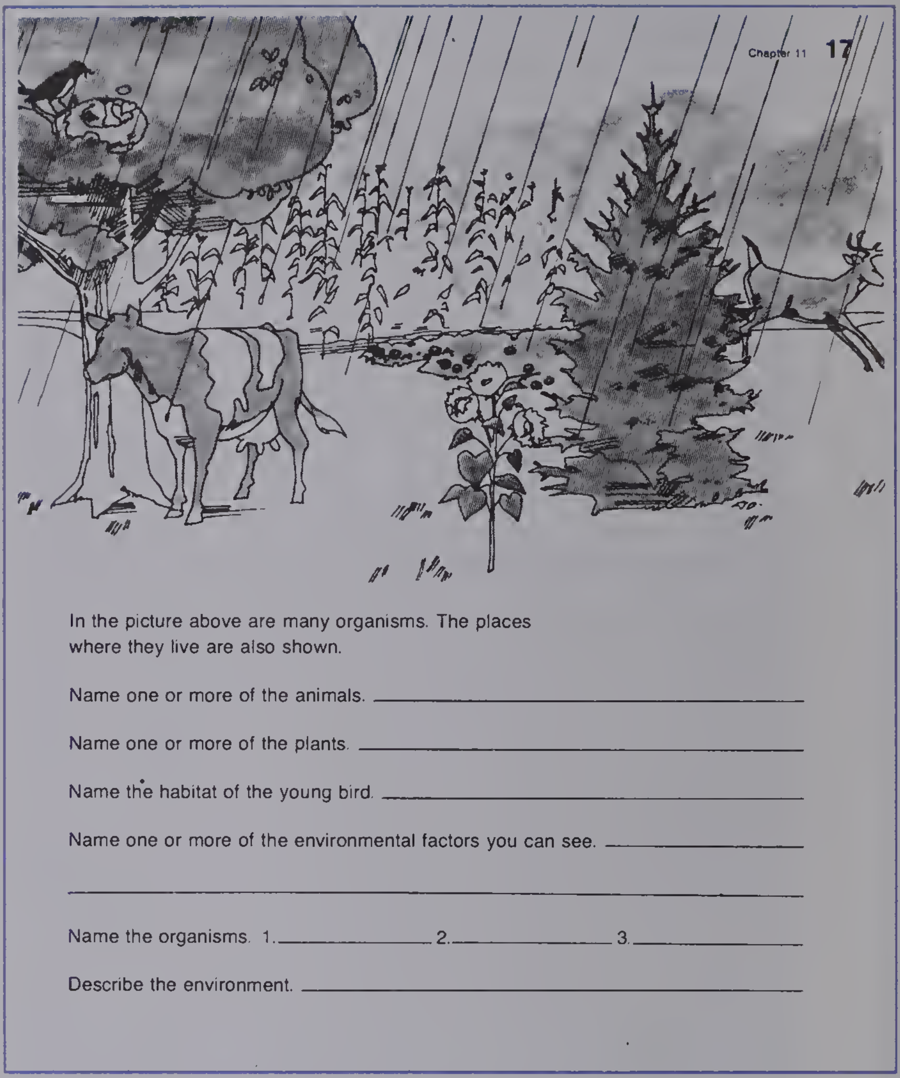
Introducing the term *terrarium*. After the planting has been completed, tell the youngsters to label the frosted end of each container with their names and the date. Before putting the containers away, explain that a *terrarium* is a container in which land organisms can live. You might hold up one of the newly constructed terrariums and tell the class that they have just constructed a terrarium.

"Inventing" *environment*. Ask the students to tell you the different environmental factors for seeds in their terrariums. List the factors on the chalkboard and label the column "Environmental Factors." The children's list will probably include such terms as "moist," "no wind," "some chemicals," "soil," and "room temperature." Explain to them that all of these factors in combination make up an *environment*, and write the word to the right of the list. You might add a bracket to show that the one word encompasses all the factors together.

Each terrarium may be placed wherever a team thinks conditions will be best for the development and growth of their plants. Allow short observation and watering periods over the next week. Use of the lids is optional at this time. If your classroom is dry (low humidity), you may want to use the lids to reduce evaporation of water from the start.

Using student manual page 17. Ask the students to complete this page after you have introduced the term environment. *Habitat* (the place where an organism lives) may be unfamiliar to students who have not had previous SCIIS life science units. This page may help students straighten out any misconceptions they have about the differences between habitat, environmental factor, and environment, and review that organisms are plants or animals. A discussion of the students' answers for this page may prove worthwhile to the students and allow you to assess their level of understanding regarding these terms.

Ready for the animals. The terrariums will be used to house the hermit crabs, isopods, and beetles when they arrive. If these animals arrive before the plants sprout, they can still be placed in the terrarium. However, the children are usually very pleased to see the animals in an actively growing forest of plants within the terrarium.



Chapter 11 17

In the picture above are many organisms. The places where they live are also shown.

Name one or more of the animals. ____________________

Name one or more of the plants. ____________________

Name the habitat of the young bird. ____________________

Name one or more of the environmental factors you can see. ____________________

____

Name the organisms. 1.__________ 2.__________ 3.__________

Describe the environment. ____________________

Receiving Shipment EN-1. When the organism shipment arrives, immediately open the containers. These animals have probably been inside the containers for two days or more, and they must have fresh air, moisture, and food—in that order.

Tell the children that the organisms are called land hermit crabs. These animals do live on land and are called hermits, not because they live alone, but because they live by themselves in the cast-off shells of other animals. As an animal grows, it must leave its present shell and find another one.

Caution the children to handle the crabs carefully and not drop and injure them, as the shells may break. They sometimes roll suddenly, especially if startled. Distribute the crabs, one to each team of two, or let the children come to the distribution stations to get their own. Crabs can pinch, but it is an uncommon problem with the size crabs you have received. Allow the youngsters five to ten minutes of exploratory time with these new animals. Have the students put the crabs in the terrariums before proceeding further.

In a similar manner, distribute an isopod and a beetle to each child. Isopods are best carried in the palm

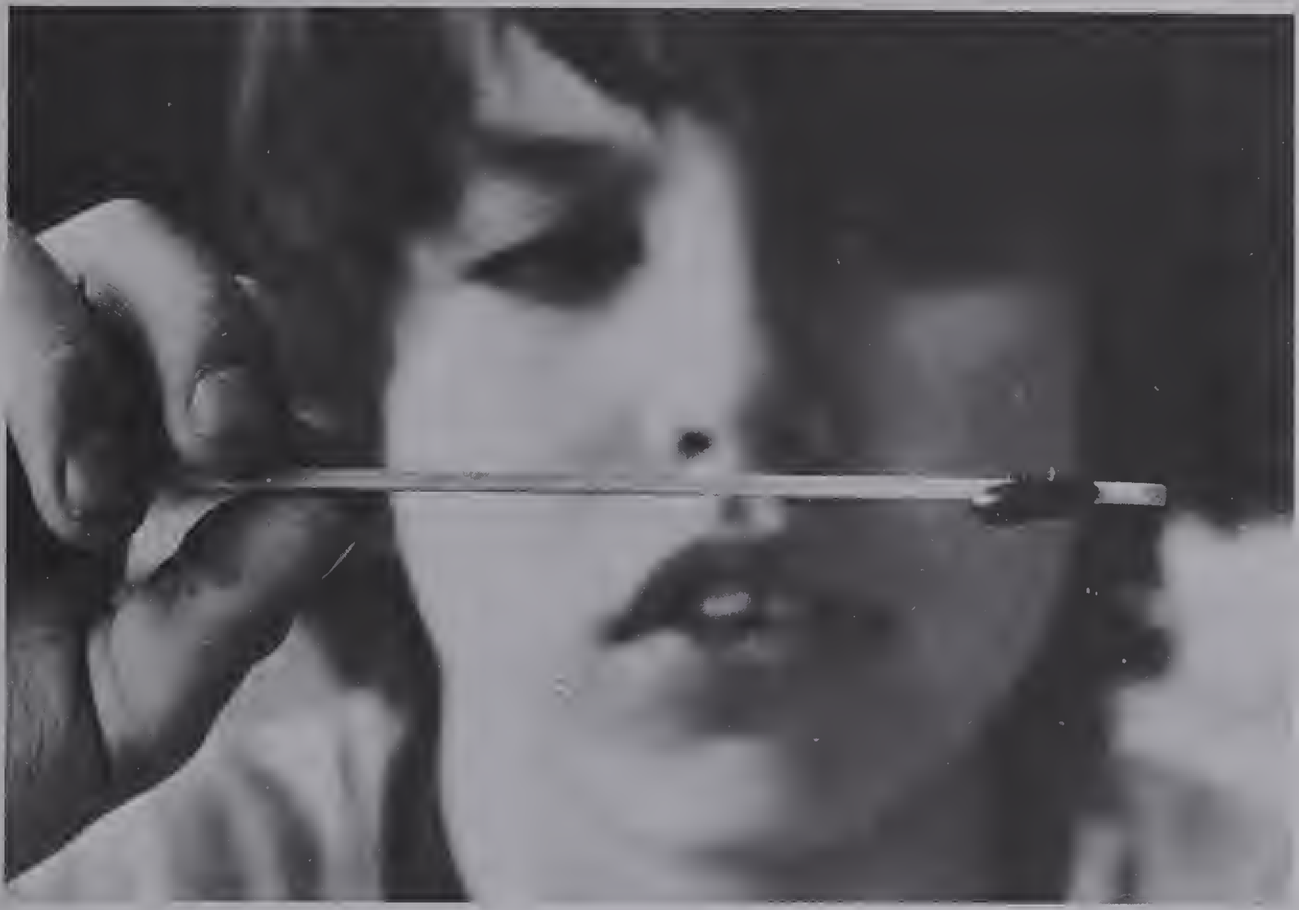


Figure 11–2. Some children may prefer handling beetles in this way at first.

of the hand. Beetles are fairly adept at staying on a wooden stick, which tends to relieve some of the children's early apprehensions about those fast-moving, long-legged creatures.

After distributing the animals, allow sufficient time for the children to examine them before suggesting they cover the terrariums to keep the animals inside.

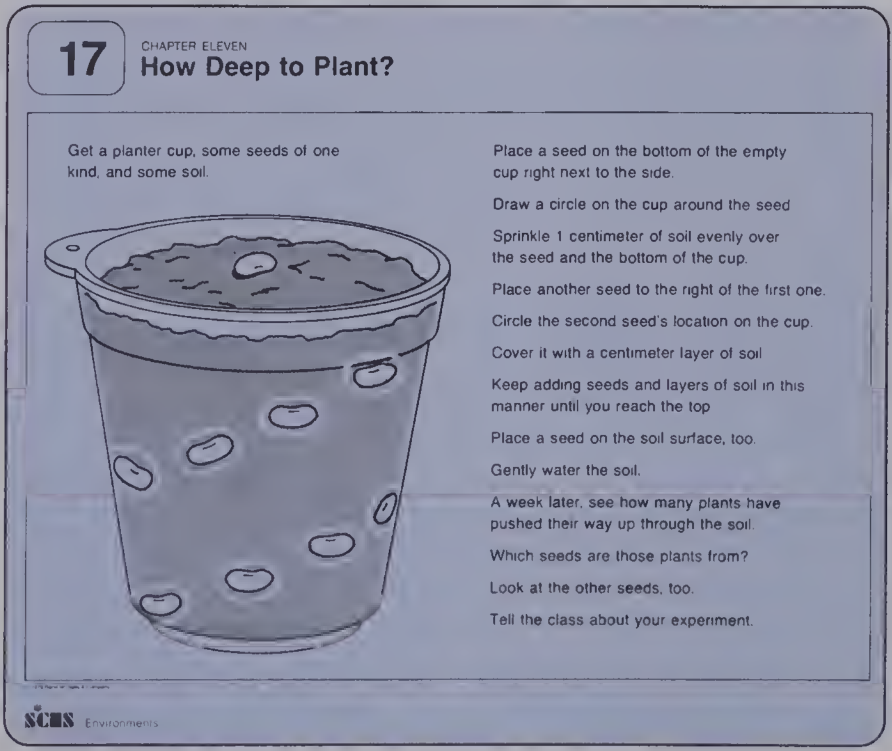
Feeding the animals. If the children's plants have not yet sprouted, add a piece of wet lettuce (about a quarter of an outer leaf in size) to each terrarium. This will take care of food for all three kinds of animals. You may wait until the next day to add the lettuce, as the animals were well-fed prior to shipping.

Air and water are the most important environmental factors for shipped animals. The beetles and isopods do not need additional water, but the crabs need to have a container of fresh water available at all times.

Setting up your classroom cultures. Any remaining animals that were not distributed should be housed in separate culture systems. See the "SCIIS Plants and Animals" section for complete setup and maintenance techniques. Proper maintenance of these extra animals will assure your children of having sufficient animals for all of their experiments.

EXTENDING YOUR EXPERIENCE CARD

17. How Deep to Plant? Children selecting this card will need one planter cup and base, soil, and about ten seeds of one kind. They may plant the seeds directly above one another, but the results are usually clearer if they are planted in a spiral from the bottom of the cup to the top and right next to the plastic so their progress can be observed. The experiment will require about one week with most seeds, a little longer with slow-growing seeds.



17

CHAPTER ELEVEN

How Deep to Plant?

Get a planter cup, some seeds of one kind, and some soil.

Place a seed on the bottom of the empty cup right next to the side.

Draw a circle on the cup around the seed

Sprinkle 1 centimeter of soil evenly over the seed and the bottom of the cup.

Place another seed to the right of the first one.

Circle the second seed's location on the cup.

Cover it with a centimeter layer of soil

Keep adding seeds and layers of soil in this manner until you reach the top

Place a seed on the soil surface, too.

Gently water the soil.

A week later, see how many plants have pushed their way up through the soil.

Which seeds are those plants from?

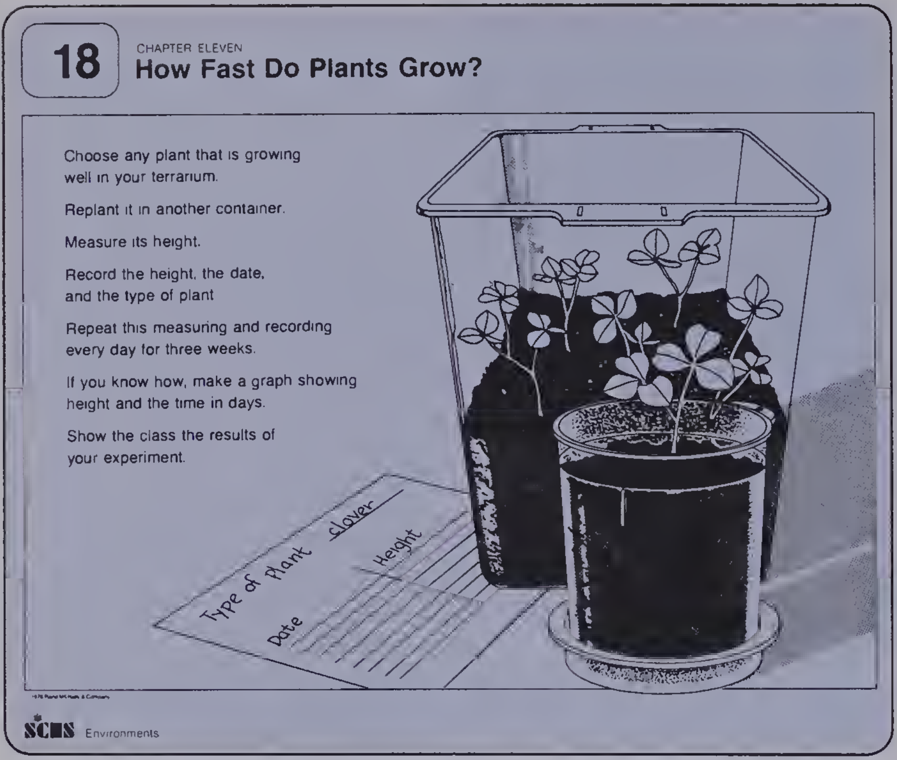
Look at the other seeds, too.

Tell the class about your experiment.

SCIIS Environments

18. How Fast Do Plants Grow? The student will need a planter cup and base, a growing plant, a little soil, a water sprinkler, and a notebook or record paper.

Several children can do this experiment at once, each child studying a different kind of plant under the same conditions. Then they can compare the results.



18

CHAPTER ELEVEN

How Fast Do Plants Grow?

Choose any plant that is growing well in your terrarium.

Replant it in another container.

Measure its height.

Record the height, the date, and the type of plant

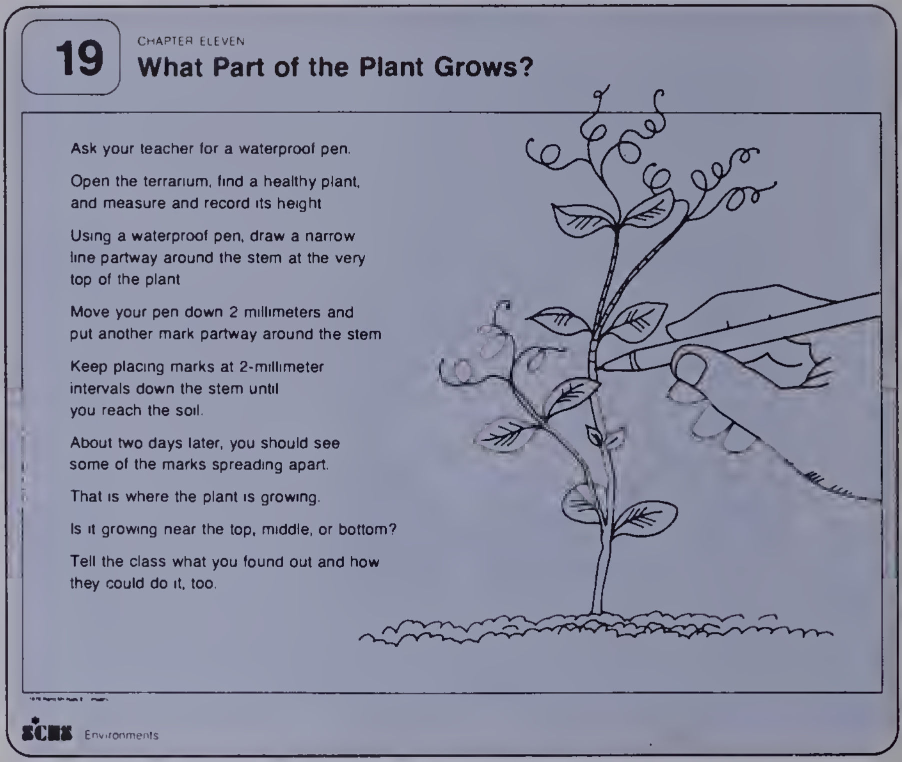
Repeat this measuring and recording every day for three weeks.

If you know how, make a graph showing height and the time in days.

Show the class the results of your experiment.

SCIS Environments

19. What Part of the Plant Grows? Students selecting this card will need a waterproof pen, ruler, and record page. Watch to be sure they are following the instructions on the card. If waterproof ink is not readily available, you might suggest that the child use a fine toothpick to dip some ink from a felt-tip marker. The toothpick then can be used as a pen.



19

CHAPTER ELEVEN

What Part of the Plant Grows?

Ask your teacher for a waterproof pen.

Open the terrarium, find a healthy plant, and measure and record its height

Using a waterproof pen, draw a narrow line partway around the stem at the very top of the plant

Move your pen down 2 millimeters and put another mark partway around the stem

Keep placing marks at 2-millimeter intervals down the stem until you reach the soil.

About two days later, you should see some of the marks spreading apart.

That is where the plant is growing.

Is it growing near the top, middle, or bottom?

Tell the class what you found out and how they could do it, too.

SCIS Environments

12 Temperature and Isopods

SYNOPSIS

Children investigate the responses of isopods to a wide range of temperatures, from which the isopods select the optimum temperature.

Suggested time: ***one session, with the possibility of a repeat test during a second session***

TEACHING MATERIALS

For each child:

student manual pages 18 and 19

For each team of two children:

3 isopods
crayons*

Drawer 2

plastic trough
metal strap

Drawer 3

metal cylinder
tumbler support
6 adhesive dots, red

Drawer 4

tumbler
2 thermometers

For the class:

5 light/heat sources (assembled in Chapter 8)
felt pen*
tape*
80–100 ice cubes or crushed ice*

Drawer 1

Isopods' Response to Temperature graph

Drawer 3

5 bulb support rings
5 aluminum pans

Drawer 4

2 extension cords

Drawer 5

2 six-liter containers

* provided by the teacher

ADVANCE PREPARATION

Obtain a bag of ice cubes for the day of the experiment and place this ice in a 6-liter container. Fill another container with water. Refresh your knowledge of how to assemble the trough systems and the light/heat sources. Obtain the metal cylinders from drawer 3 and show one of the children how to twist one into the round hole in the bottom of a plastic trough, so the cylinder is tight against the metal strap. That student can then insert all the other cylinders for you.

Establish three distribution stations, with some of each item at each station. Decide where to set up the five light/heat sources and trough systems so the children will have sufficient space to move and work around the experimental setups.

TEACHING SUGGESTIONS

This activity focuses on the children's attention to an animal's response to high and low temperatures. It begins the discovery phase of the learning cycle for *range* and *optimum*.

Explaining the experiment. To begin, tell the children that they will be investigating the responses of isopods to various temperatures.

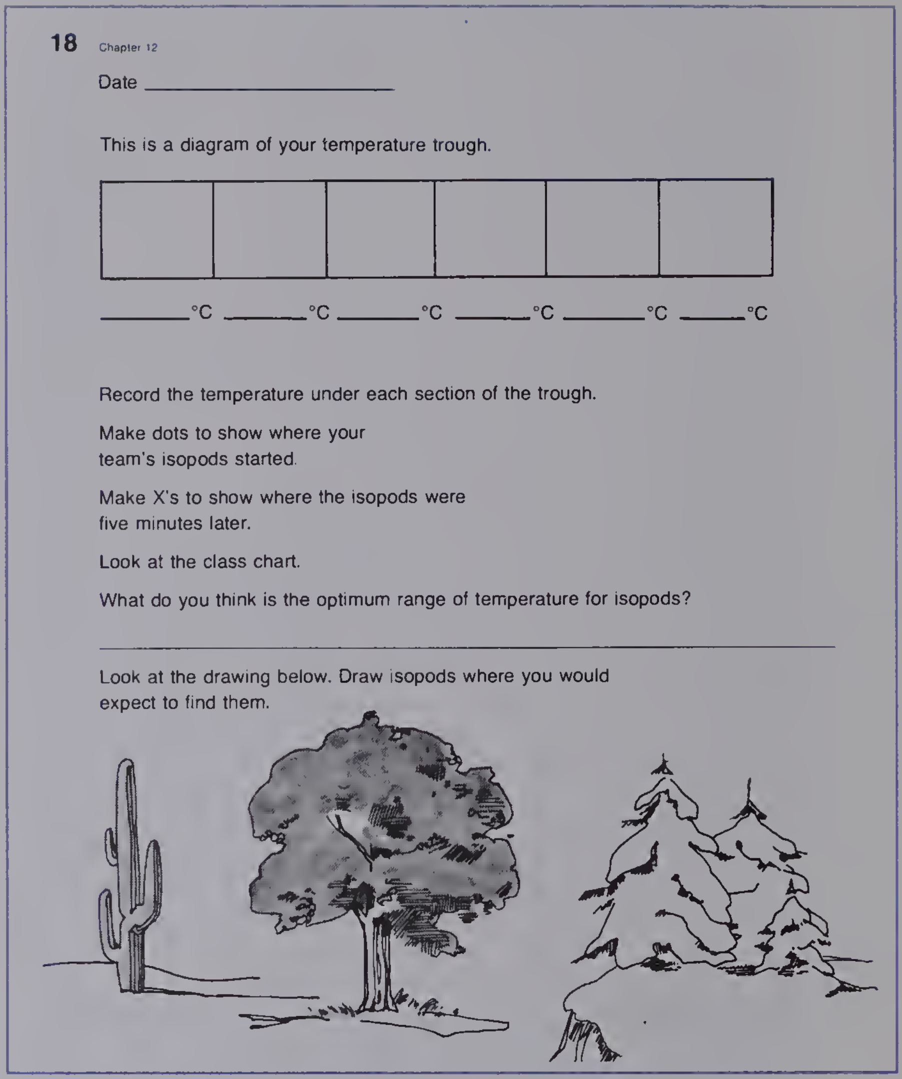
- Remind the children of isopods they may have seen while on one of the field trips earlier in the unit. Where did they find them? What environmental factors were present? Which one of those factors did the isopods prefer? (We have learned that although nearly all children have seen isopods under rocks, bricks, or logs, children almost never know whether it is because the isopods prefer the moisture under the rock, the food under the rock, the temperature under the rock, the chemicals under the rock, or if the isopods just prefer being together under the rock.)
- After you have raised these questions, ask how they might determine what temperature the isopods prefer.
- They will probably suggest letting the isopods loose in a wide range of temperatures and seeing where they go. (They will not word their statements in this way, but this is usually the intent of their suggestions.)
- As the children suggest how to do the experiment, modify their suggestions as necessary to conform to available equipment.
- As you have done before, draw an elementary sketch of the trough system on the chalkboard as the children suggest how many isopods to test at one time, where they will place them at the beginning, and how long they should let the

isopods walk around before marking the results and restarting them.

Setting up the experiment. Divide the class into teams of two or three and assign three teams to each light/heat source. One person from each team is to bring one trough system to the assigned lamp. Another team member should half-fill a tumbler with water and add three ice cubes. Go to each of the lamps and assemble one trough system for one of the teams. This will serve as a guide for the other teams who should set up their systems in the same way. With the troughs supported at one end by the light/heat source and by the tumbler support and tumbler at the other, they should be level. The cylinders should be in the ice water. The lamps should be turned on so that the temperatures will be stabilized. Using your finger, check the temperature of the metal strap right above the tumbler to see if it is cold. If not, the metal cylinder may not be tightly seated against the metal strap—or the cylinder is not in the ice water. Adjust the cylinder so that the end of the strap near the tumbler becomes cold.

Using student manual page 18. Call the children's attention to this page, where they should record their experimental data.

The troughs should be marked off into six sections, matching the diagram.



18 Chapter 12

Date ______________________

This is a diagram of your temperature trough.

_____°C _____°C _____°C _____°C _____°C _____°C

Record the temperature under each section of the trough.

Make dots to show where your team's isopods started.

Make X's to show where the isopods were five minutes later.

Look at the class chart.

What do you think is the optimum range of temperature for isopods?

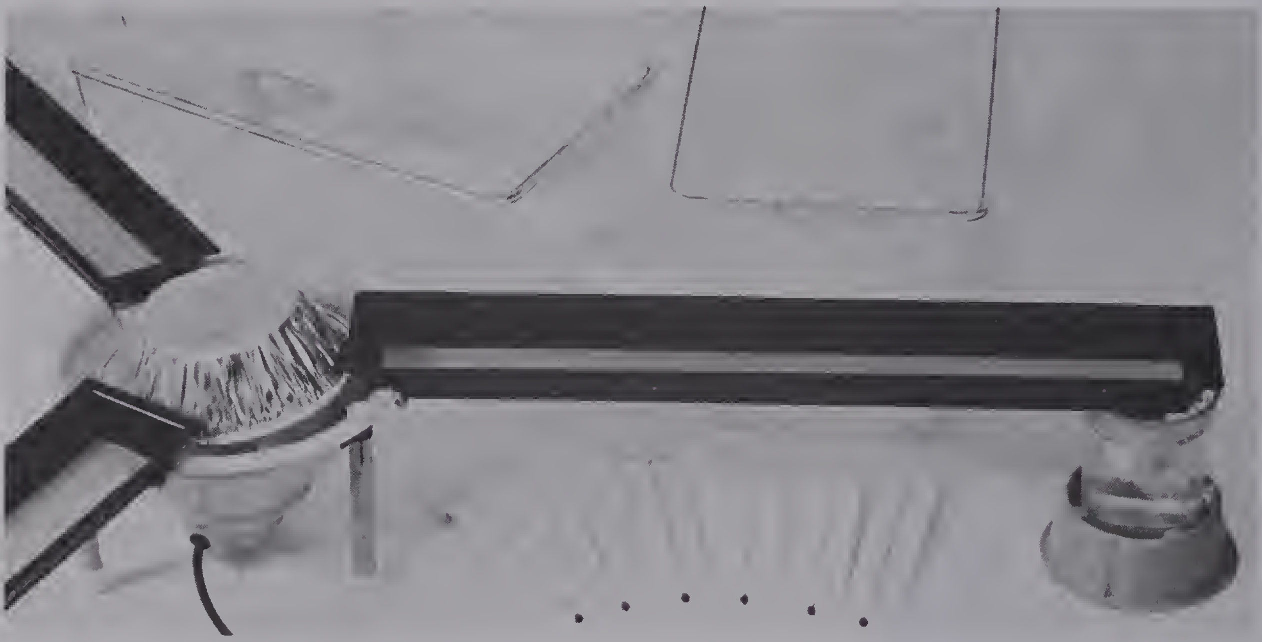
____

Look at the drawing below. Draw isopods where you would expect to find them.

Experimenting. Each team needs two thermometers. They can record the temperatures by placing the red bulb on the center of each section, reading the temperature after one or two minutes, and recording the temperature in the appropriate section of the student manual illustration. Let them begin by getting their own isopods and placing them into the troughs.

Visit the different teams to see how they are doing and to learn the different ways the students approach the experiment. If the students are measuring the temperatures at the same time that they are testing

Figure 12-1. Trough systems in position for the temperature experiment.



the isopods, and the isopods are spending most of their time under the thermometers, suggest to the students that they hold the thermometer up so that only the bulb touches the trough section. An alternative is to stop the isopod tests until the temperature is measured.

Cleanup. After each team has conducted the experiment with their isopods, unplug the light/heat sources. Have the students return their animals to the terrariums, and the troughs, lamps, thermometers, tumblers, and supports to the distribution centers or to the kit.

Using the graph. Display the Isopods' Response to Temperature graph and give each team six dots. Using the data recorded in their manuals, tell the children to place a dot on the line that corresponds to the temperature of the trough section where each isopod was recorded at the end of the test. Dots should be placed one above the other on the appropriate vertical line. A complete chart might appear like Figure 12-2.

Reviewing *range*. When all the teams have recorded their data on the chart, ask one team to tell you what temperatures they recorded in the six trough sections. Ask which temperature is coldest, which is next coldest, and so on. Record these data on the chalkboard in a line from coldest to hottest (such as 7°, 16°, 25°, 31°, 37°, 46°C).

Ask the students what these numbers represent. If they do not suggest "the range of temperatures," you should do so. Then ask the children to determine the lowest and highest temperatures recorded. Using a marking pen, circle these two temperatures on the graph, explaining that these indicate the limits of the temperature range for the class experiments.

Ask the children to think of other examples of temperature range (you may wish to suggest possibilities, such as the daily temperature range for your area). Also ask the children to suggest ranges of other environmental factors (for example, a range of light or water).

Reviewing *optimum*. Refer to the graph and ask at which temperatures most of the isopods were found (19° in Figure 12-2). Are there any temperatures where just a few isopods were found? Are there temperatures where no isopods were found? Ask the children what to call the segment where most of the isopods were found. If they don't remember the term optimum temperature, remind them. Explain that animals of a certain kind generally move to the optimum amount of a factor, and ask the children what their tests indicate the optimum temperature is.

Note: Save the graph for later use.

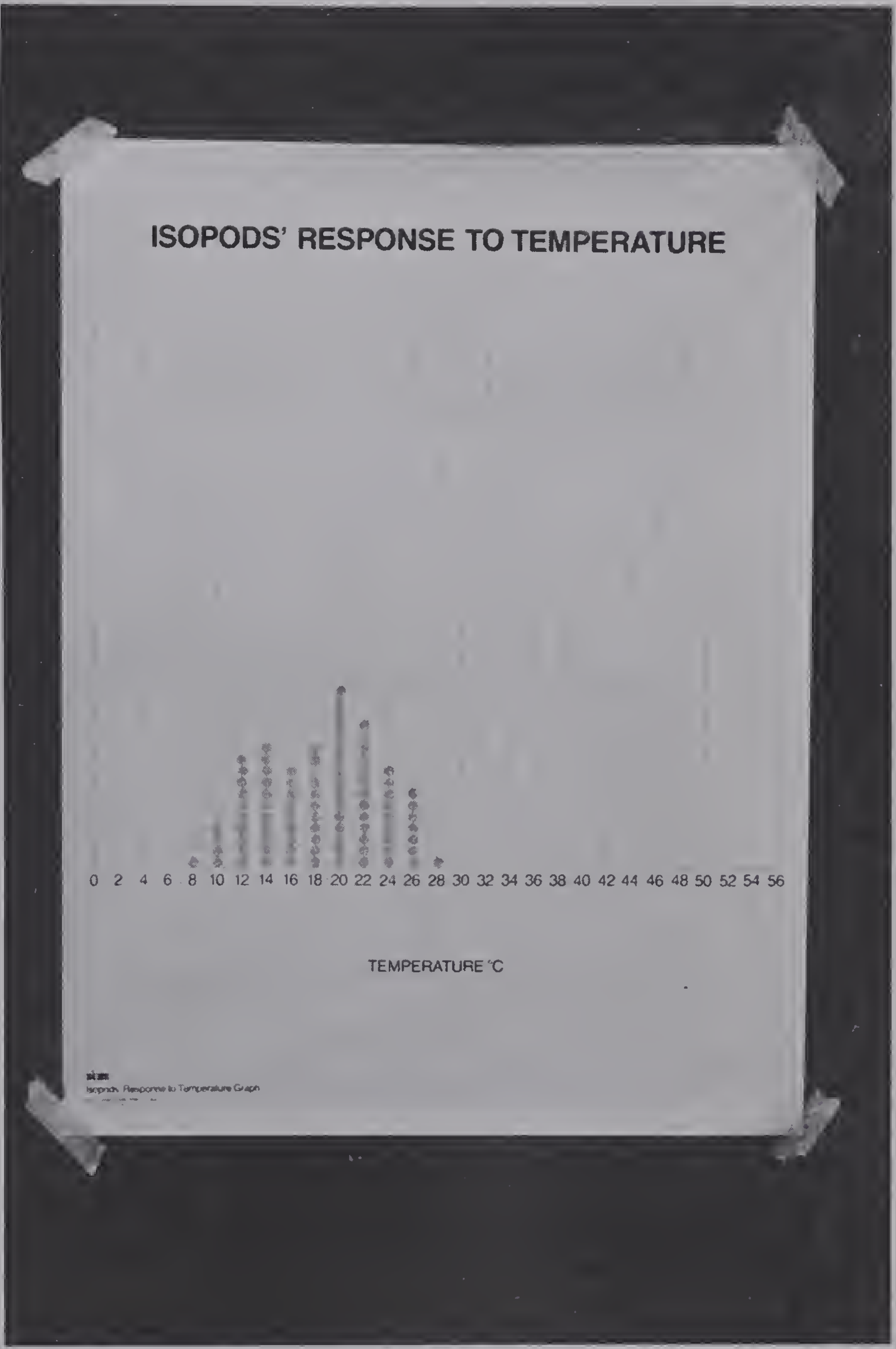
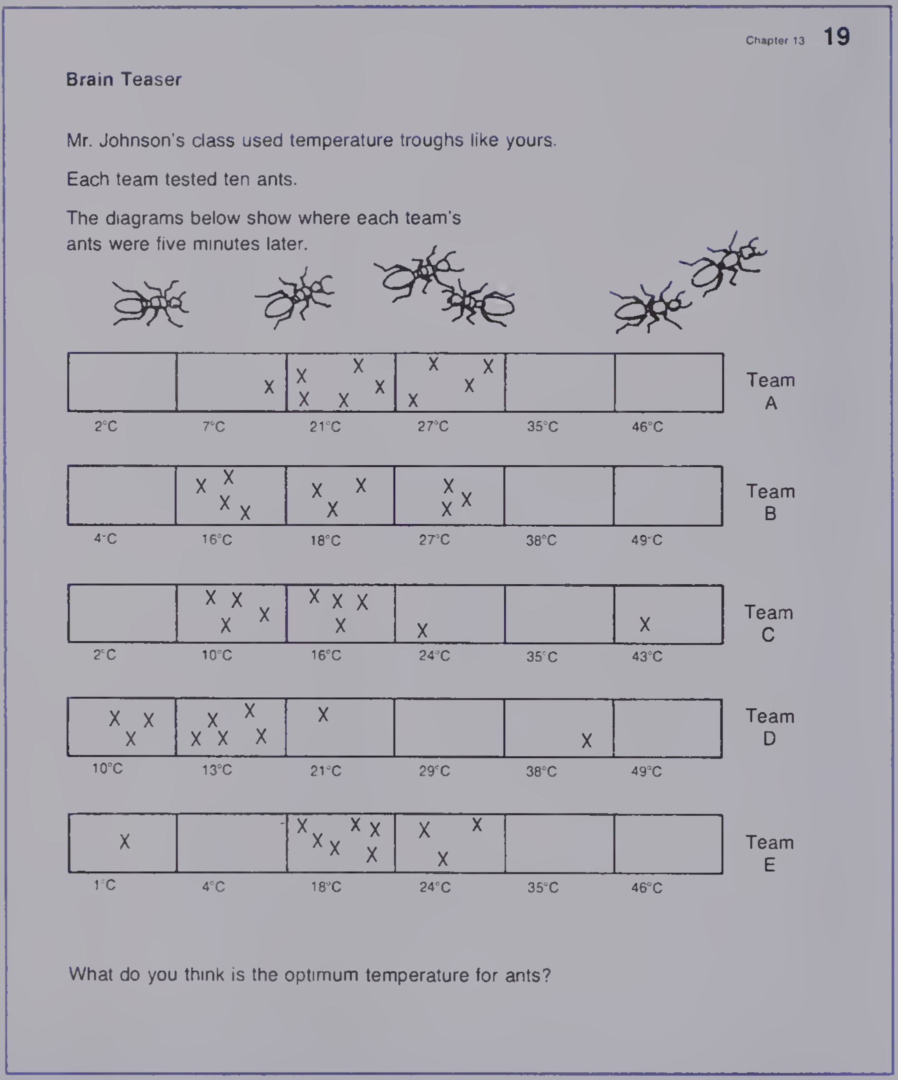


Figure 12-2. Example of a completed chart.

Discussion. Ask the children to describe the isopods' behavior in the troughs. Did they move in a certain direction, or did they wander at random? Did isopods seem to react to any particular temperature? How did they react? Did any isopods stay at either end of the trough? What happened to them? Allow the children to speculate about the advantages of animals being able to move to a place having the optimum temperature for those animals.

Using student manual page 19. The brain teaser on this page will give the children additional experience in interpreting data. You may wish to suggest that they construct histograms to combine the data. (Some pupils may need assistance in constructing a number line.)



Chapter 13 19

Brain Teaser

Mr. Johnson's class used temperature troughs like yours.

Each team tested ten ants.

The diagrams below show where each team's ants were five minutes later.

	X	X X X X X	X X X X			Team A
2°C	7°C	21°C	27°C	35°C	46°C	
	X X X X	X X X	X X X			Team B
4°C	16°C	18°C	27°C	38°C	49°C	
	X X X X	X X X X	X		X	Team C
2°C	10°C	16°C	24°C	35°C	43°C	
X X X	X X X X X	X		X		Team D
10°C	13°C	21°C	29°C	38°C	49°C	
X		X X X X X X	X X X			Team E
1°C	4°C	18°C	24°C	35°C	46°C	

What do you think is the optimum temperature for ants?

OPTIONAL ACTIVITIES

Lowering the temperature. Some children may be curious about the effect of lower temperatures on isopod behavior. If so, give them the opportunity to modify their systems to reduce the temperature of the cold end. A piece of dry ice carefully placed under the trough should make that end considerably colder than in the previous experiment.

Temperature range outdoors. Your students may wish to measure the temperature range outside the classroom. They may not realize that temperatures given on newscasts or in newspapers are for only a small area, and that another area only a short distance away may be several degrees warmer or colder, depending on exposure to the sun. Divide the class into groups to measure the temperature range in the vicinity of the school. Each group should take several temperature readings in different parts of the school yard—both in the sun and in the shade. At least three readings should be taken in a particular area: at ground level, 15 centimeters above the ground, and a meter above the ground.

The class may also take temperatures of specific areas: under rocks, on the fence, or on the playground, for instance. The children can make a "temperature map" of the school yard with these readings. Write the temperature readings on the chalkboard and ask what the outside temperature range was when the readings were taken. Would the range have been different at another time of day? Relate the outside temperature range to the isopod experiment. Ask the children to refer to the Isopods' Response to Temperature graph and to use the data to predict where isopods might be found in the school yard at a particular time. Save the temperature map for possible use in the optional activity "Isopods in the school yard," in Chapter 13.

13 The Best Environment for Isopods

SYNOPSIS

Children apply their understanding of range and optimum as they experiment to determine the responses of isopods to different intensities of light and different amounts of moisture.

Suggested time: ***two or three sessions***

TEACHING MATERIALS

For each child:

student manual pages 20–22

LIGHT TEST:
For each team of two children:

2 isopods
scissors*
crayon*

Drawer 2

plastic trough
trough cover
metal strap

Drawer 3

tumbler support
2 adhesive dots, red

Drawer 4

tumbler
tumbler lid

For the class:

tape*

Drawer 1

Isopods' Response to Light graph

WATER TEST:
For each team of two children:

2 isopods
felt pen or crayon*
paper towels*

Drawer 2

trough insert

Drawer 3

10 labels
2 adhesive dots, red

Drawer 4

tumbler
tumbler lid

For the class:

tape*
soil‡

Drawer 1

Isopods' Response to Water chart

Drawer 4

4 water sprinklers

* provided by the teacher
‡ Sand and Soil box

ADVANCE PREPARATION

Equip three distribution stations with some of each of the required materials. Set up materials for only the light or moisture test on any one day.

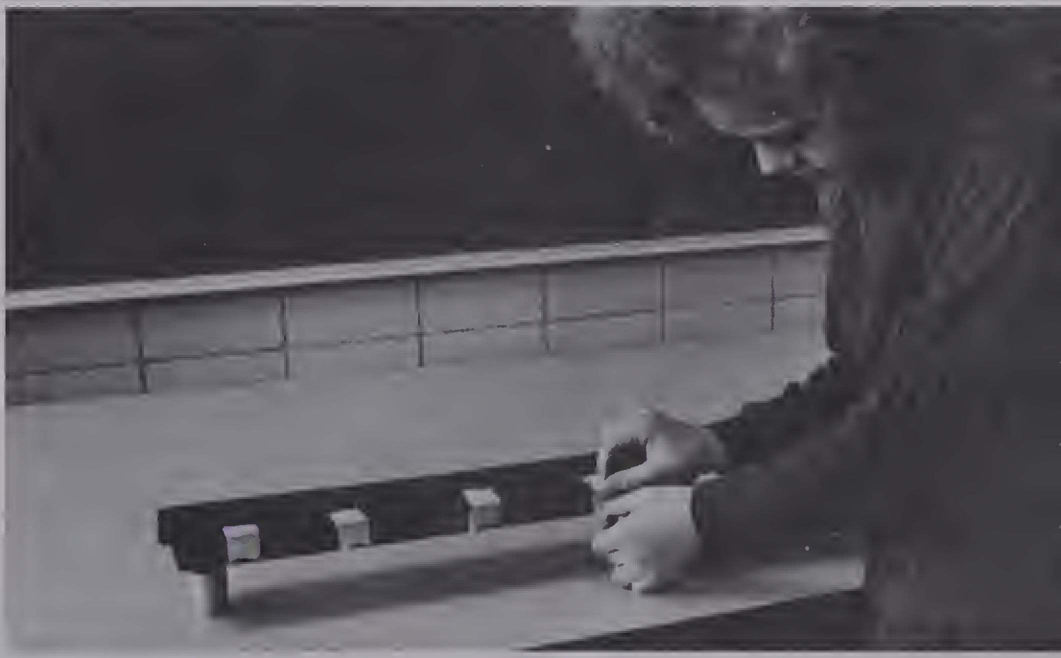
TEACHING SUGGESTIONS

There are several ways for conducting the activities in this chapter, in which the discovery phases of the *range* and *optimum* learning cycles are contained. The class can run the experiments as described, or your pupils may wish to determine which environmental factors they will test and develop their own techniques. If the children work individually or in small groups, each experiment should be repeated several times, so that enough data are accumulated to make comparisons possible.

Isopods and light. Explain to the children that they can investigate the response of isopods to another environmental factor—light. Let them discuss possible ways to do this. Their comments should give you some insight into how well they have grasped the range concept. For example, do they suggest that the isopods be tested in a range of light intensities?

Planning the experiment. Set up a demonstration trough system by resting one end of a trough on the metal strap and place the other end on a tumbler support. Show the students the trough cover and how it can be taped onto the top of the trough to block out light except where the hole is located. The trough now has only one source of light—the hole at one end. The part of the trough directly under the hole is the lightest, and it becomes progressively darker toward the opposite end (Figure 13-1).

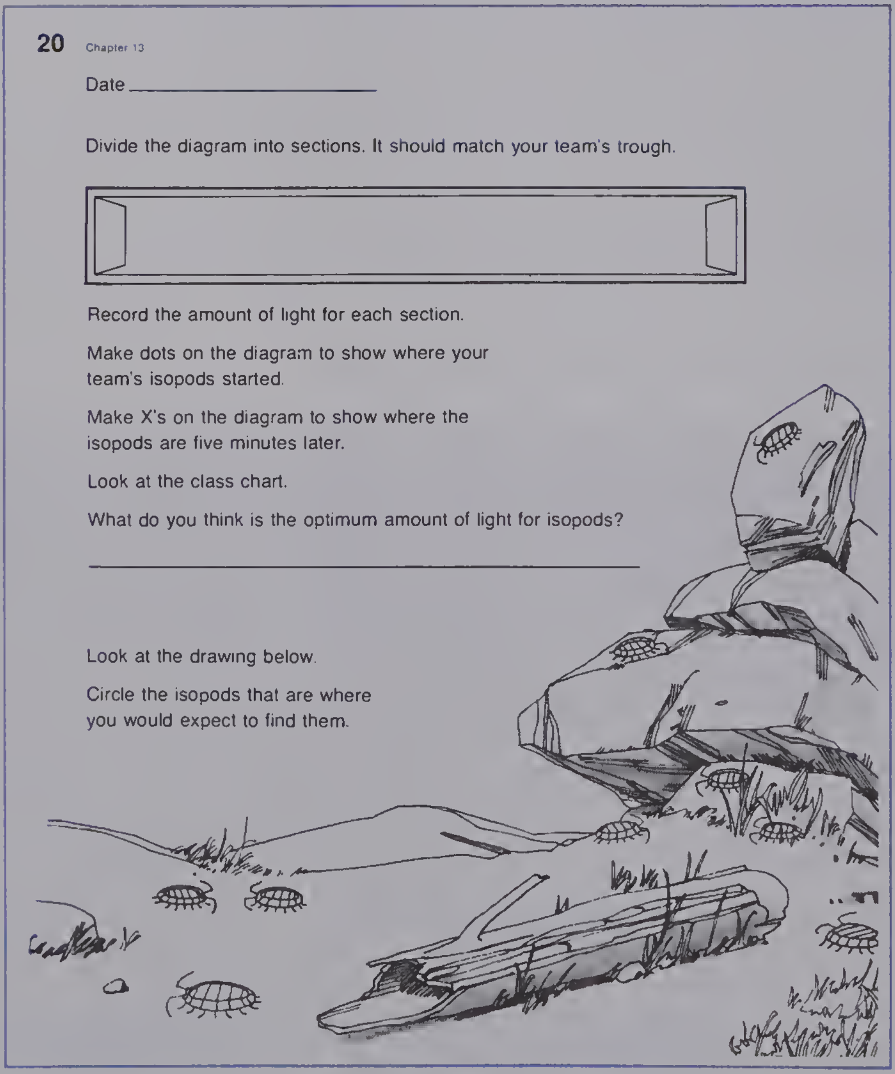
Figure 13–1. Creating a range of light intensities.



When the teams have set up their troughs, the children will have to translate the range of light intensity into terms that everyone understands. Let the children decide into how many sections they will divide the troughs and what to call each section. They may use a crayon to mark lines on the trough bottom, labeling the sections, "bright," "medium," "dim," and "dark," for example. The children might prefer to measure distances from the hole and name the light intensity accordingly. For example, the area directly below the hole would be the "brightest," 12 cm away would be "darker," and so on.

Testing isopods: student manual page 20. Have the children divide and label the diagram. Have each team get their isopods from the terrarium, lift the trough cover, and drop the isopods into the trough. Suggest that individual children be responsible for recording isopod positions in each section of their team's trough. After about five minutes, a child should lift the cover (without bumping the trough) so all the children can quickly record the isopods' positions in the student manual diagram.

Return the isopods to the classroom container and save the troughs for use in the water test.



20 Chapter 13

Date ____________________

Divide the diagram into sections. It should match your team's trough.

Record the amount of light for each section.

Make dots on the diagram to show where your team's isopods started.

Make X's on the diagram to show where the isopods are five minutes later.

Look at the class chart.

What do you think is the optimum amount of light for isopods?

____

Look at the drawing below.

Circle the isopods that are where you would expect to find them.

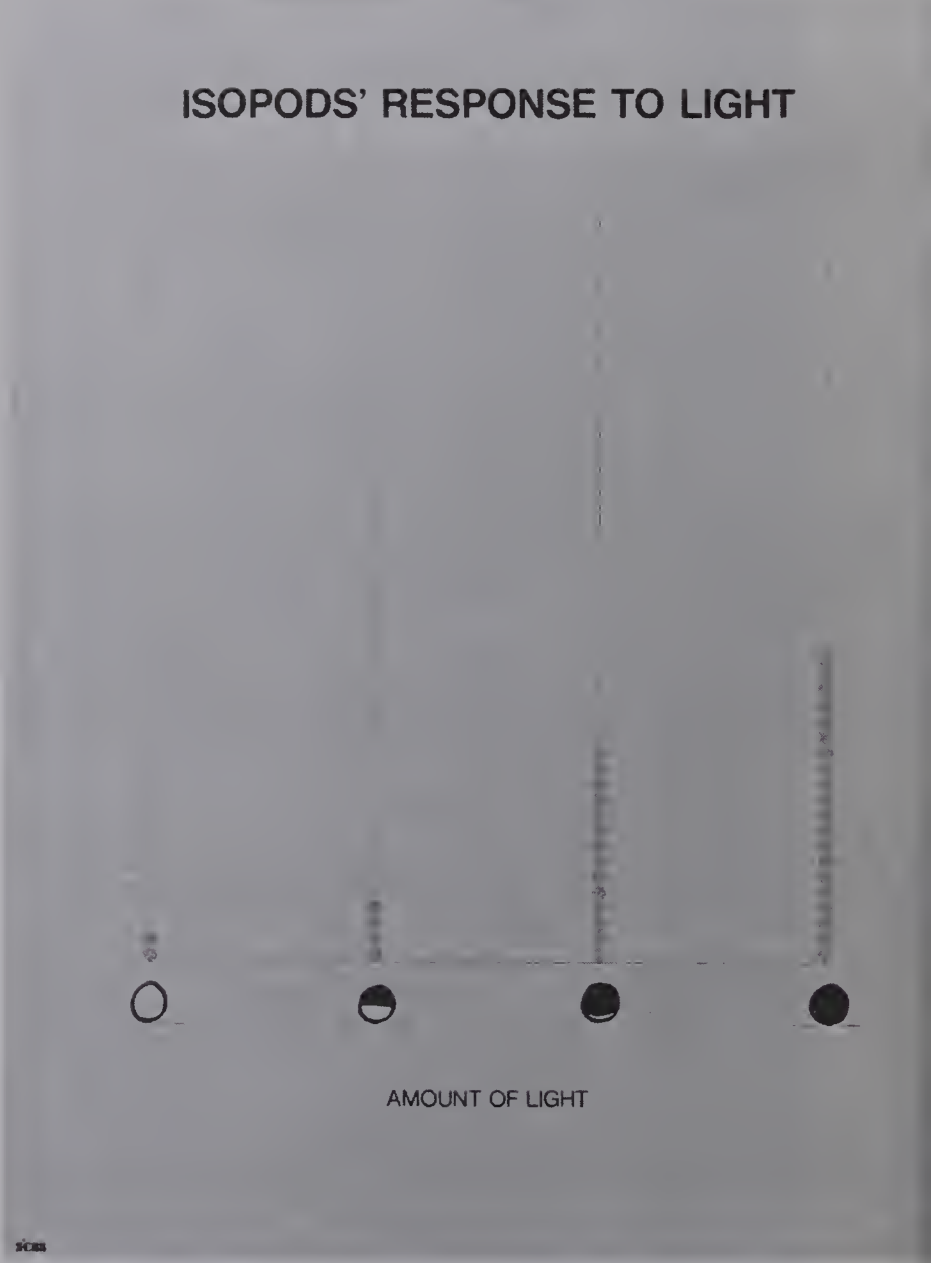


Figure 13–2. Sample of a completed chart.

Discussion. Display the Isopods' Response to Light graph and label the vertical lines to indicate the light range the children agreed upon. Have the children indicate the number of isopods found in each intensity of light by adding adhesive dots to the appropriate vertical line from bottom to top, as shown in Figure 13-2. Caution your students not to cover each other's dots.

When the children have completed recording their findings, gather them for a discussion. Ask the children if the data on the chart suggest the optimum light for isopods. This question should stimulate a discussion. There are at least two ways you can direct the discussion, depending on the children's answers to the question:

1. If all the isopods appeared in the darkest (or lightest) part of the trough, the children will probably conclude that this is the optimum light for isopods.

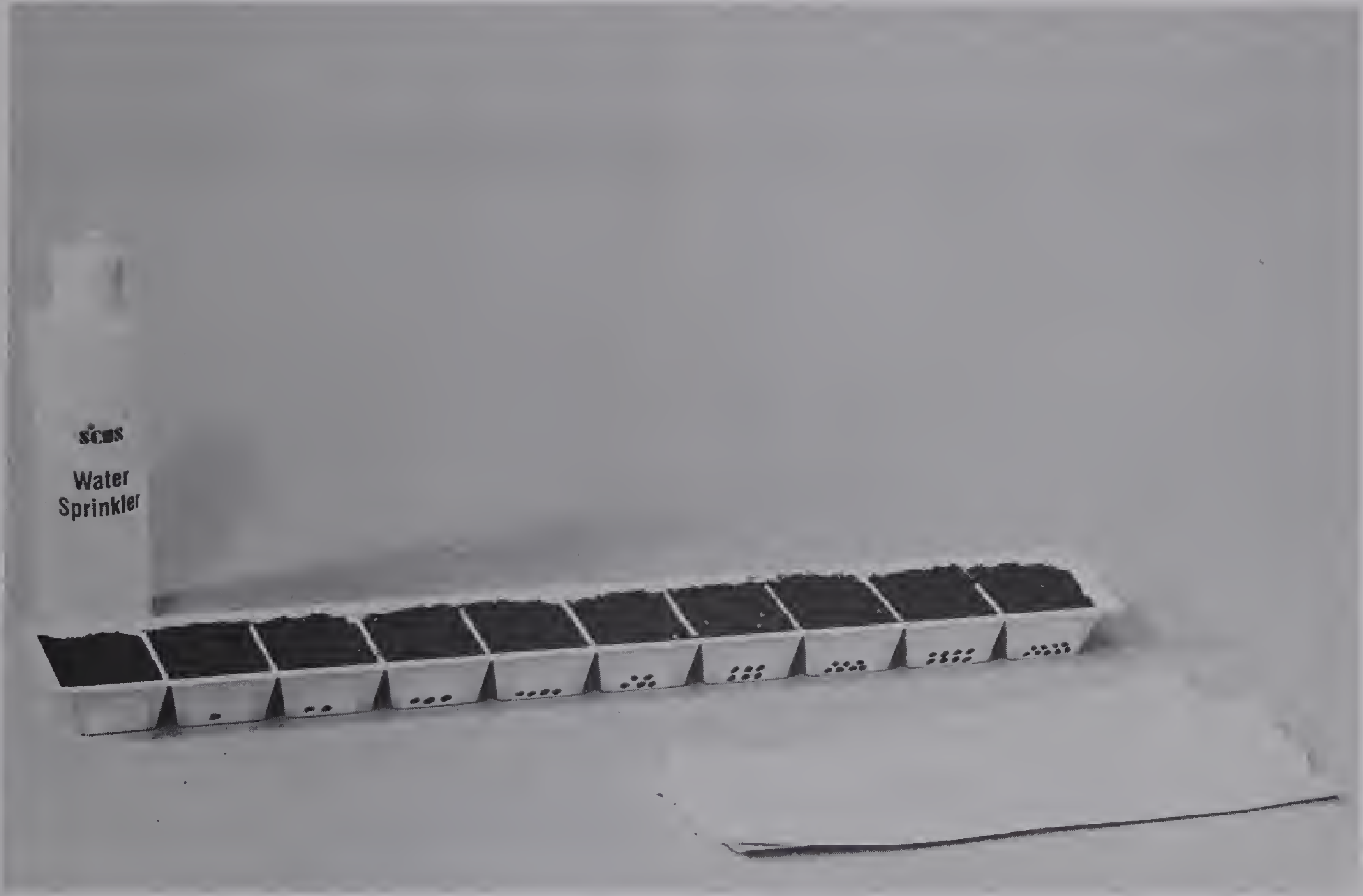


Figure 13-3. Labeling the moisture experiment inserts.

2. If the isopods were randomly distributed in the troughs, the children may conclude either that isopods do not respond to light or that all teams did not run the experiment in the same way.

If the latter is the case, let the children suggest possible differences in their experiments and remind them that such differences are called *variables*. They may suggest variables such as the available light in the area where the experiment was conducted, the kind of tape used for attaching the trough cover, or the position of the isopods at the start of the experiment.

The children's responses in this discussion should give you feedback about their understanding of controlled experiments. If necessary, remind them that in a controlled experiment, only the variable being tested should change; all other conditions should remain constant. For example, if isopod response to light is being tested, then the temperature and other variables should be the same in all tests; only the light factor should vary.

Your pupils may want to run additional experiments to control some of the variables they pointed out. Their data may be recorded on separate sheets similar to student manual page 20.

Isopods and water. Next, perhaps on another day, the children will investigate isopod response to another factor. Suggest that they try to determine the optimum moisture for this animal. Let the children discuss possible ways to conduct the moisture test. If they do not suggest providing a wide range of moisture, this would be a good time to review the range concept.

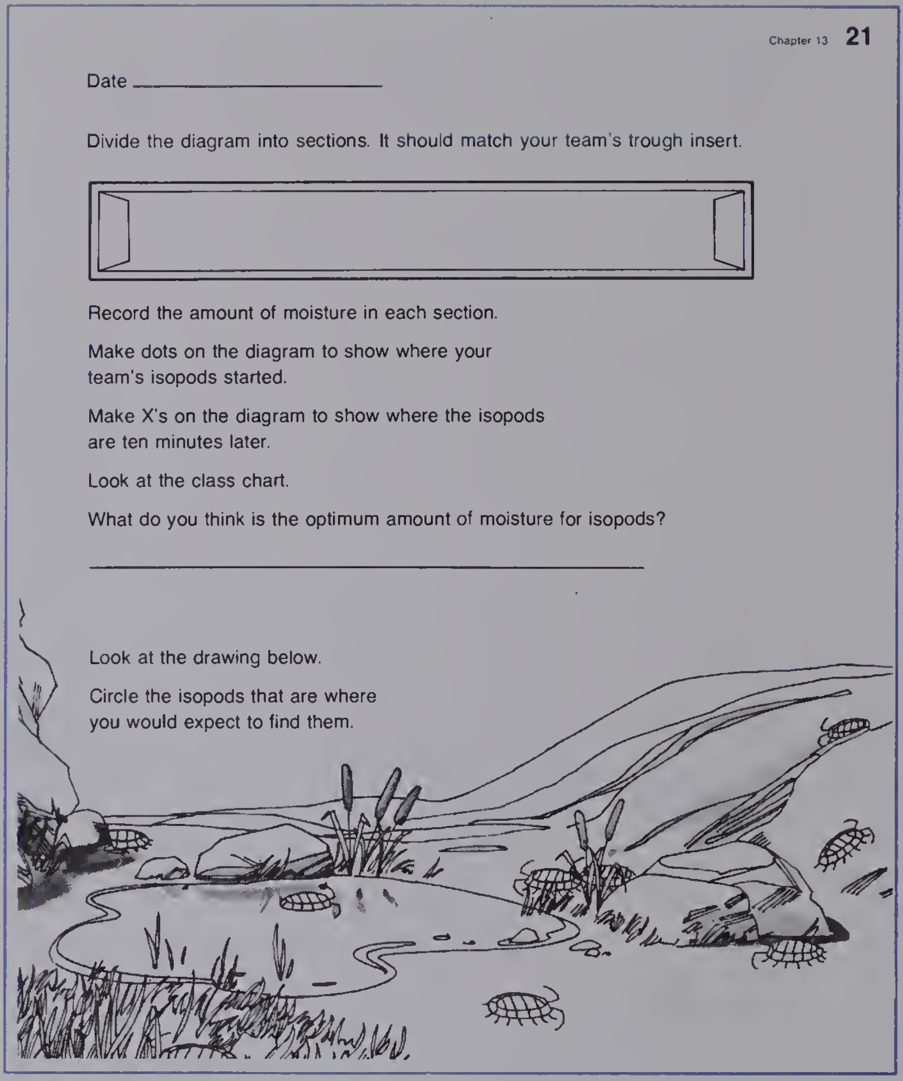
Experimental setup. Divide the class into teams of two and distribute the equipment. If the children do not have ideas of their own, you might show them how to set up the moisture experiment in the following way:

1. Add just enough soil to reach the tops of the dividers of each insert.
2. Use the labels to mark each section with numbers, raindrops, or some other symbols representing the various degrees of moisture (Figure 13-3).
3. Use the sprinklers to water the sections according to the amounts of moisture indicated on the labels. In the example illustrated, each drop of water on the label represents one squirt from the sprinkler.

Testing the isopods: student manual page 21. Have the children divide and label the diagram on this page, then get their isopods. After the children have placed their isopods in the trough inserts they should wait no less than eight minutes before recording the positions of the isopods. If some teams wish to run several tests, placing the isopods in different sections each time, have them make copies of this page and record their data on the copies.

Return the isopods to the terrariums when the tests are finished.

Discussion. Display the Isopods' Response to Water chart and label the horizontal axis to match the children's setups. The children should mark each isopod's position with a dot placed along the vertical line above the appropriate label. After recording has been completed, let the children describe how the isopods responded. Do the class data show the optimum moisture for isopods? Ask the children what they think the response of isopods would be if their environment became very dry or was flooded.



Chapter 13 21

Date ____________

Divide the diagram into sections. It should match your team's trough insert.

Record the amount of moisture in each section.

Make dots on the diagram to show where your team's isopods started.

Make X's on the diagram to show where the isopods are ten minutes later.

Look at the class chart.

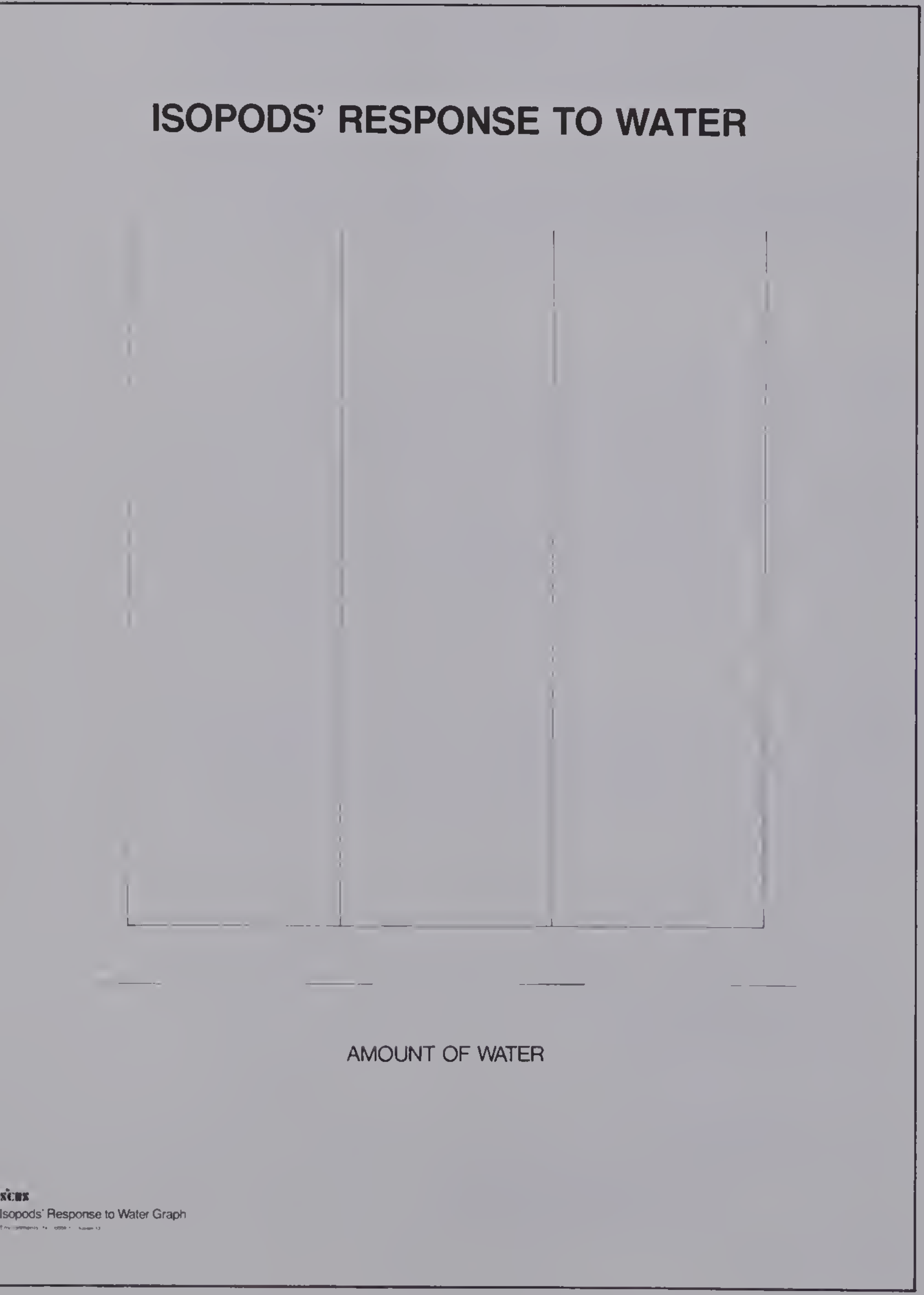
What do you think is the optimum amount of moisture for isopods?

____

Look at the drawing below.

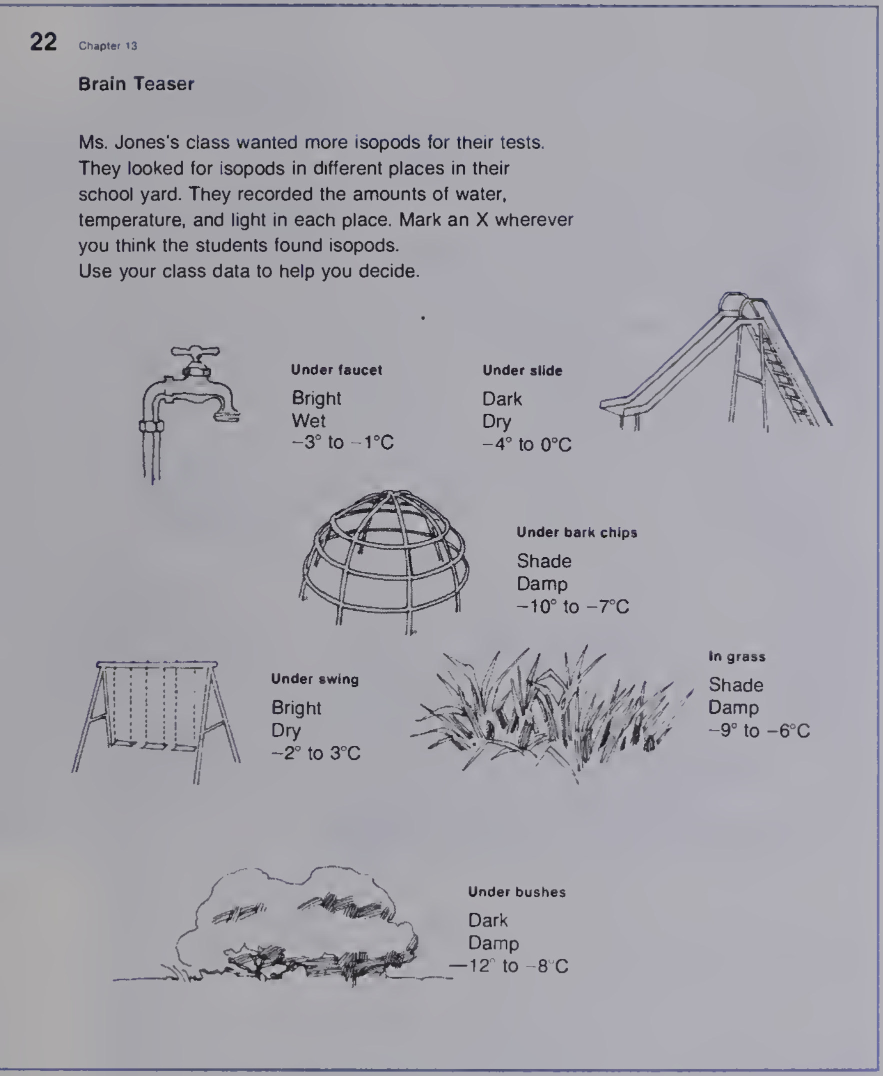
Circle the isopods that are where you would expect to find them.

Figure 13–4. The Isopods' Response to Water chart.



An isopod's environment: student manual page 22. Display the three isopod graphs so the children can review their data. On the basis of the data, ask them to indicate on page 22 the places where isopods might be found. A class discussion of this page should give you feedback about the children's understanding of the environment concept.

Note: Save the charts for use in Part Five.



22 Chapter 13

Brain Teaser

Ms. Jones's class wanted more isopods for their tests. They looked for isopods in different places in their school yard. They recorded the amounts of water, temperature, and light in each place. Mark an X wherever you think the students found isopods.
Use your class data to help you decide.

Under faucet
Bright
Wet
−3° to −1°C

Under slide
Dark
Dry
−4° to 0°C

Under bark chips
Shade
Damp
−10° to −7°C

Under swing
Bright
Dry
−2° to 3°C

In grass
Shade
Damp
−9° to −6°C

Under bushes
Dark
Damp
—12° to −8°C

OPTIONAL ACTIVITIES

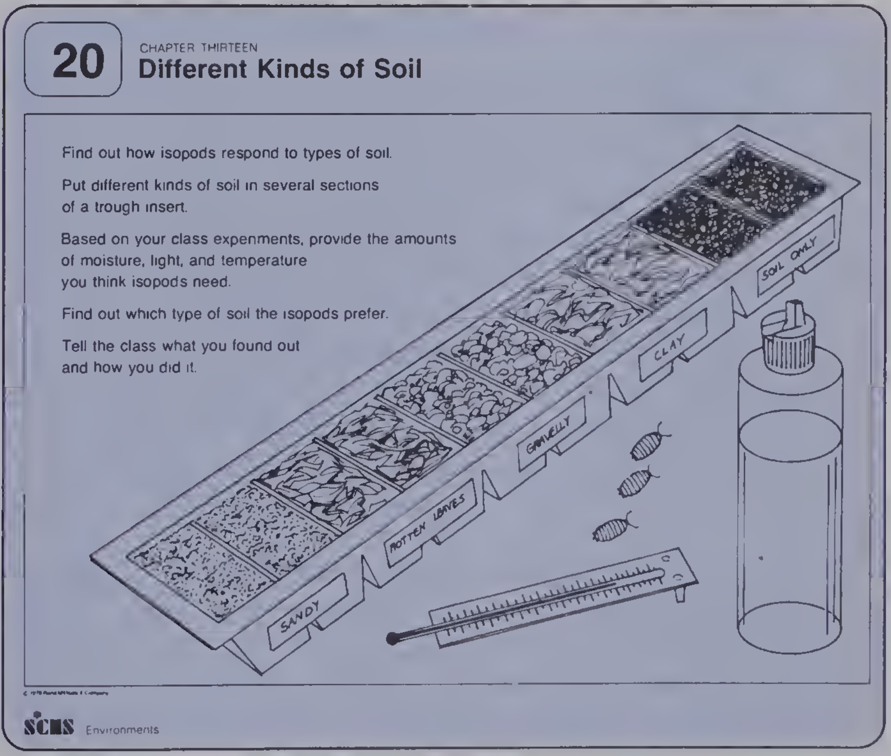
Isopods in the school yard. The children may want to predict where isopods could be found in their school yard. Divide the class into teams to measure the ranges of water and light in the school yard. One team could make a "moisture map" by checking and recording the relative degree of wetness of specific areas in the school yard. Let another team make a "light map" using similar methods. Explain to the children that they should use the same terms they used before to describe the ranges of light and water. If a temperature map was not made in Chapter 12, a third team could make one at this time.

When the children have completed the maps, display these along with the data graphs. Let the children compare the maps and graphs and decide in what areas of the school yard the three factors are found in optimum amounts for isopods. The children should look in these areas for isopods. If none are found, encourage your pupils to offer possible reasons for the absence of isopods.

The children may wish to make a new map combining all their information.

EXTENDING YOUR EXPERIENCE CARDS

20. Different Kinds of Soil. A student selecting this card will need to gather several different components of soil. He or she will need a trough insert.



20 CHAPTER THIRTEEN
Different Kinds of Soil

Find out how isopods respond to types of soil.

Put different kinds of soil in several sections of a trough insert.

Based on your class experiments, provide the amounts of moisture, light, and temperature you think isopods need.

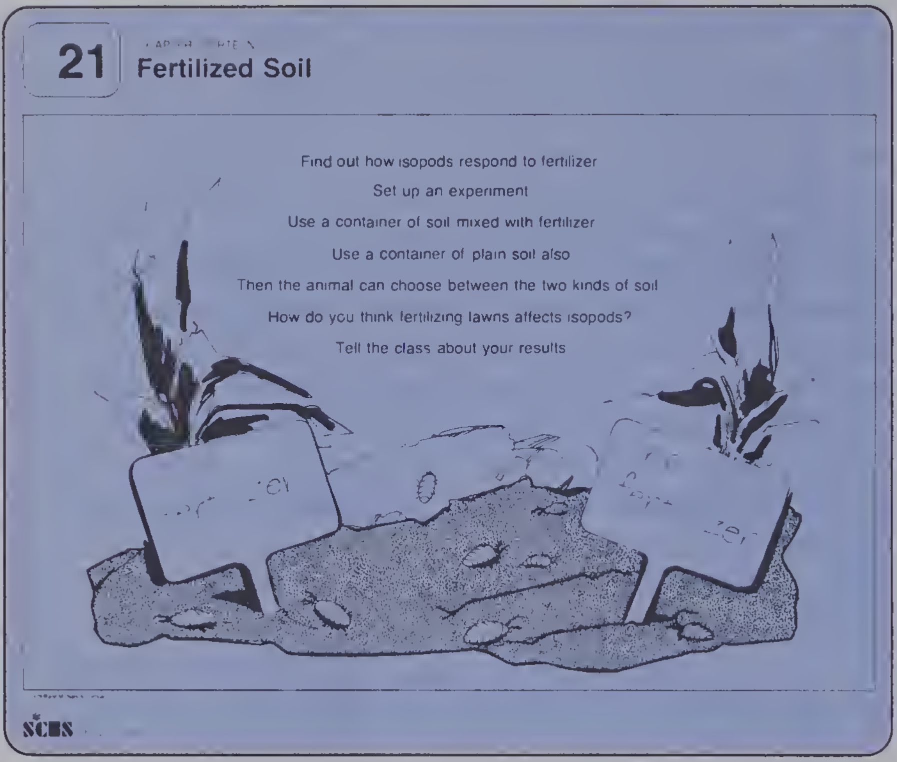
Find out which type of soil the isopods prefer.

Tell the class what you found out and how you did it.

SANDY
ROTTEN LEAVES
GRAVELLY
CLAY
SOIL ONLY

SCIS Environments

21. Fertilized Soil. This child will need some fertilizer, soil, a trough, and probably a small stick to mix the soil and fertilizer. You might observe his or her experimental setup to see if he or she controls the experiment by providing plain soil with which to contrast the responses of the isopod on fertilized soil.



21

CHAPTER THIRTEEN

Fertilized Soil

Find out how isopods respond to fertilizer

Set up an experiment

Use a container of soil mixed with fertilizer

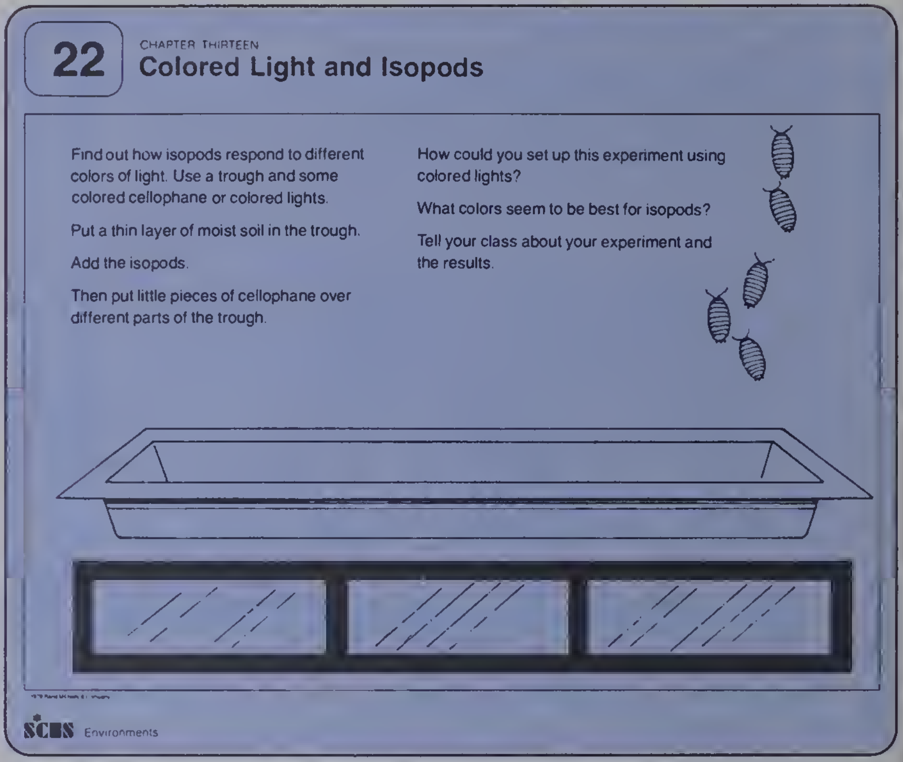
Use a container of plain soil also

Then the animal can choose between the two kinds of soil

How do you think fertilizing lawns affects isopods?

Tell the class about your results

22. Colored Light and Isopods. This student will need some colored cellophane, gel, or other translucent material which will allow different colors of light to pass. He or she may also require a trough and possibly a light source. Colored Christmas tree lights will also work if colored gels are not available from the crafts teacher; the lights can be arranged around a terrarium and the animals' movements observed. If Christmas tree lights are used, be sure they are not left burning overnight.



22

CHAPTER THIRTEEN

Colored Light and Isopods

Find out how isopods respond to different colors of light. Use a trough and some colored cellophane or colored lights.

Put a thin layer of moist soil in the trough.

Add the isopods.

Then put little pieces of cellophane over different parts of the trough.

How could you set up this experiment using colored lights?

What colors seem to be best for isopods?

Tell your class about your experiment and the results.

Environments

14

The Environment of Land Hermit Crabs

SYNOPSIS

Children experiment with land hermit crabs to determine the organisms' responses to light, temperature, and moisture.

Suggested time: ***This set of three activities will probably require three sessions, depending on how long the children spend determining the crabs' response to water.***

TEACHING MATERIALS

For each child:

student manual pages 23–25

LIGHT TEST:
For each team of four children:

- 1 land hermit crab
- flashlight or other source of cool light*

Drawer 1

- 1 transparency

Drawer 2

- plastic trough
- trough cover

Drawer 3

- 6 adhesive dots, black
- 5 bulb support rings

For the class:

- 5 light/heat sources (assembled in Chapter 8)
- overhead projector (optional)*
- felt pen (optional)*

Drawer 4

- 2 extension cords

TEMPERATURE TEST:
For each team of four children:

- 1 land hermit crab
- scissors*

Drawer 2

- plastic trough
- trough cover
- metal strap

Drawer 4

- 4 thermometers

For the class:

- 5 light/heat sources (assembled in Chapter 8)
- dark construction paper*
- 50–75 ice cubes*

Drawer 1

- Crabs' Response to Temperature chart

Drawer 3

- 15 tumbler supports

Drawer 4

- 15 tumblers
- 2 extension cords

WATER TEST:
For each team of two children:

- 1 land hermit crab
- paper towel*

Drawer 2

- trough
- trough cover

For the class:

- scissors*

Drawer 4

- 4 water sprinklers

* provided by the teacher

ADVANCE PREPARATION

Equip three distribution stations with some of each of the necessary materials for a day. Establish stations for only one major test on any one day.

For the temperature test, you will need fifty to seventy-five ice cubes. Add the bulb-support rings to the light/heat sources and invert them.

TEACHING SUGGESTIONS

The discovery phases of the *range* and *optimum* learning cycles are continued. The idea of *variation* in animals is discovered.

There are two ways you may conduct the activities in this chapter. Which approach you select may be determined by your confidence in the ability of the children to think through a problem and work it out. If you think the students can approach these problems in an efficient manner, encourage them to determine which environmental factors they will test and to develop their own techniques, using any equipment from the equipment kit. Remember that the youngsters are not familiar with the transparencies because they have not yet used them. You should show these to the students even if you do not elect to direct their investigations.

If you decide your pupils could benefit from a more structured approach to the problem of determining the crabs' responses to certain environmental factors, we have provided a sequential plan.

Describing the problem. Take a crab out of its terrarium and hold it up. Then describe the following problem and write it on the chalkboard: "We do not know the proper environment for survival of these animals. What environmental factors do we need to consider?" Encourage the students to name as many environmental factors as they can (such as temperature, light, moisture, chemicals, food, being with other crabs). Write these suggestions on the chalkboard as they are made. Tell the children that they will be testing at least three of the environmental factors: light, temperature, and moisture.

Planning the experiments. Some teachers have required rather extensive and comprehensive plans from their children while others have let the students begin "thinking with their hands" (working without a plan). We suggest that you try something in between these two extremes. The children might sketch the experimental design for each factor or write a paragraph telling you what and how they will test crabs for responses to a certain factor.

If you wish to have your students use more-structured approaches before planning their own experiments, use the directions on pages 72–73.

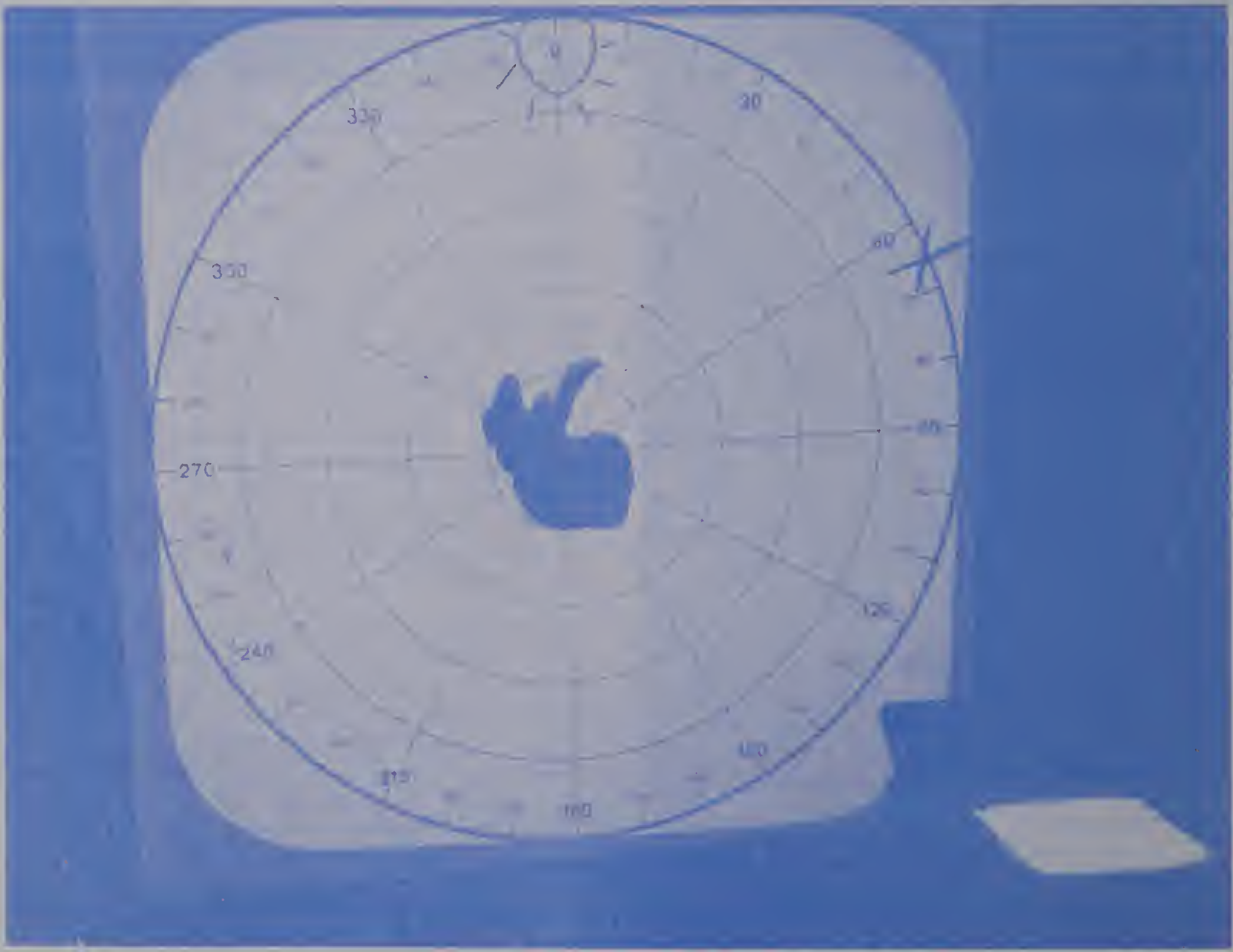
Crabs and light. Explain to the children that they can investigate the responses of crabs to the environmental factor light. Let them discuss possible ways to do this. Their comments should give you some insight into how well they have grasped the range concept. For example, do they suggest that crabs be tested in a range of light intensity? Or are they content to flash a light into the crab's eyes, see that it reacts, and conclude that it prefers dark?

The children may use any materials they wish, but first let them know that you have a new piece of equipment which may help them. Show the children one of the transparencies and demonstrate how each will fit under the bulb so that the light will be brightest at one point—the zero degree mark—on the circle. Say that they will place a crab at the center of a transparency and watch as it moves across the transparency. If you have access to an overhead projector, you can lay a transparency on the projector, place a crab at the center, and draw an outline of a light bulb at the zero degree mark to indicate the direction from which the light will be coming. Allow the demonstration crab to move freely until it reaches the perimeter of the transparency circle. Mark that crossing point with a large X. Place the crab back at the center and indicate to the children that they will repeat this procedure about six times. Before dismantling your demonstration, point to the light bulb you drew and ask the children what parts of the transparency will have the most light and the least light.

Assign three teams of two or three to each light/heat source. Set up all five systems and help the children set up their transparencies so that the zero mark is quite close to the bulb.

Testing crabs. Each team should obtain a crab and test it in the way you demonstrated. After each test, have them return the crab to the center for another test. Each team should run six tests, resulting in six dots appearing on each transparency after all experi-

Figure 14–1. Demonstrating how to arrange the transparency, the crab, and the light/heat source.



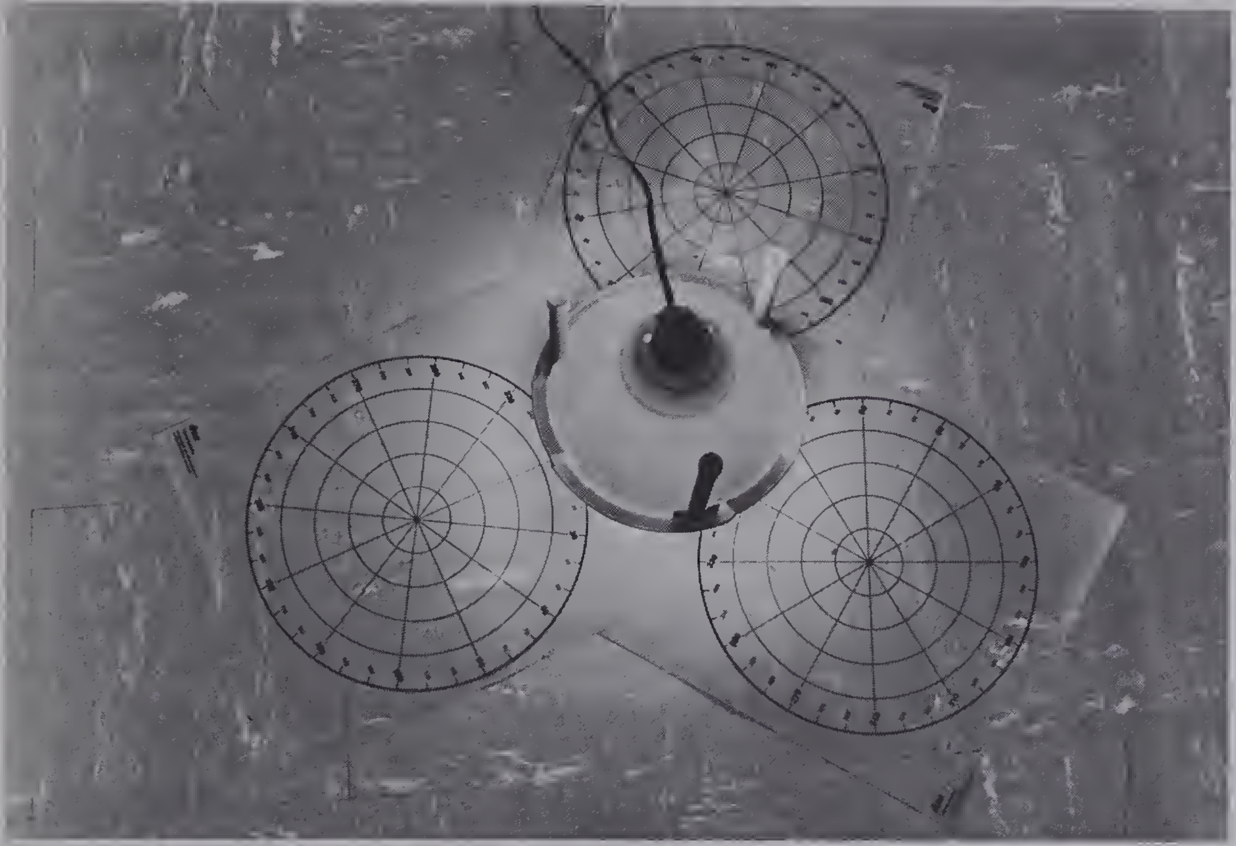


Figure 14–2. Correct positioning of the light/heat source and transparencies is important.

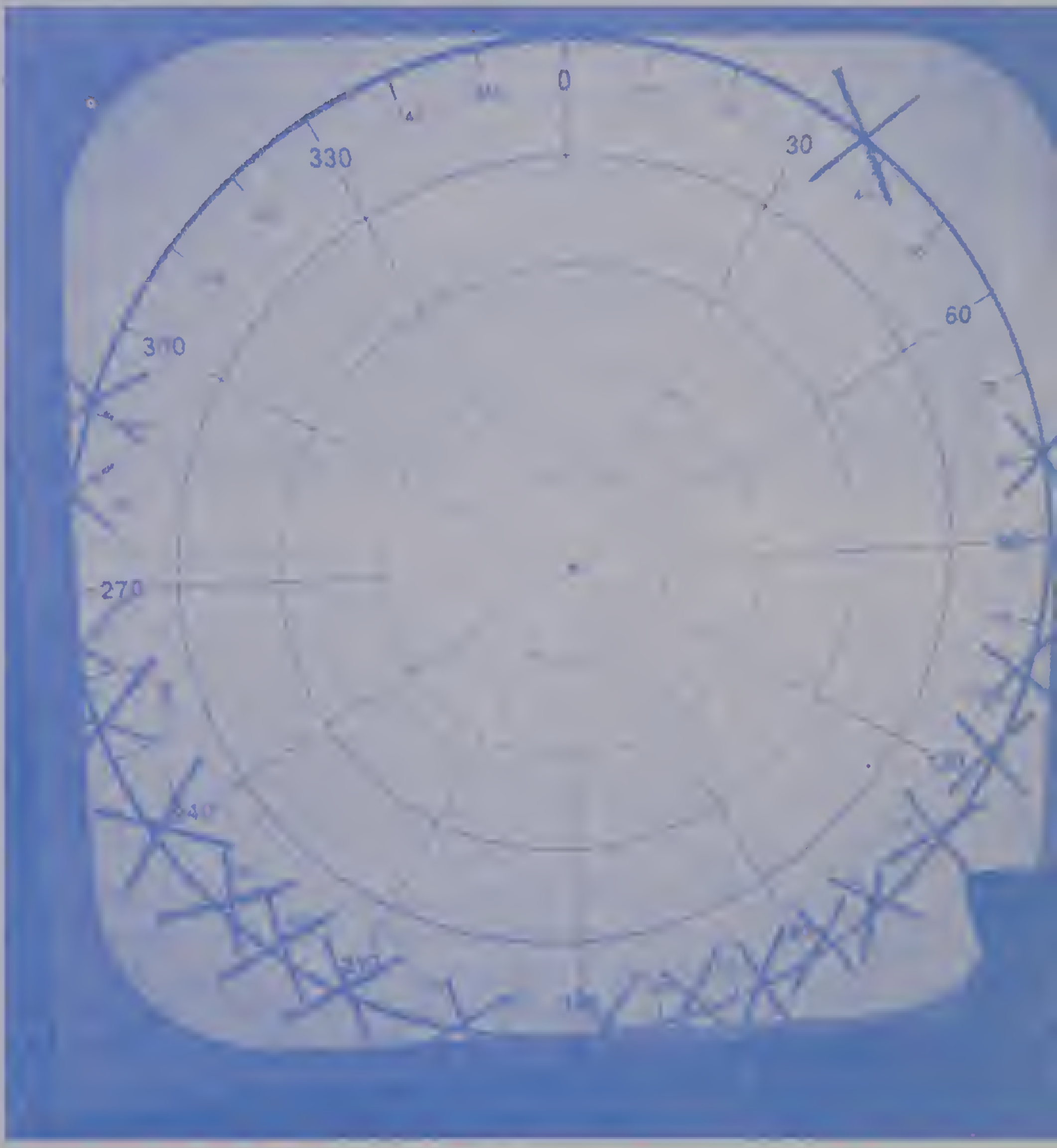


Figure 14-3. Displaying the results of several transparencies for comparison.

ments are concluded. (Each child should have the opportunity to do at least two of the tests.)

If a crab stays at the center, it may be due to the interference caused by children's movements. Crabs have good eyesight and may become startled. After the children have completed the experiment, they should initial the transparencies and replace the crabs in the terrariums. Collect the transparencies.

Viewing the results. (The data from this experiment can be better displayed with an overhead projector than by holding the overlays against a window or in your hands.) Select one transparency and project it or hold it up for the class to see. You might suggest that this crab's responses to light represents all the crabs' choices. This statement should produce some lively denials and lead to a discussion of the disadvantages of forming conclusions on the basis of evidence gathered from only one crab. This is especially true if you have selected a transparency showing markedly different results.

You might ask your students how many crabs' responses they think are necessary in order to make a reliable judgment. (There is no exact number, but the more the better.) To provide more data for discussion, place a second transparency over the one you have already shown, matching the numbers. The children can now see through both overlays and observe twelve different responses. Continue to add overlays in this manner and encourage the children to discuss the general trend of the crabs' direction of travel.

TEACHER NOTE ON STRATEGY

This experimental design is deliberately flawed. While it seems very logical and the children may have carried out the experiment well, there are in reality *two variables*—light and heat—acting upon the crabs at the same time. So, if a majority of the crabs moved away from the bulb, we cannot know if it was the heat or light of the bulb to which they were responding. While this may appear to be trickery to the children, who are accustomed to thinking that all books, experiments, and authors are correct, it is a valuable lesson for them. They now not only have the opportunity to determine what is wrong and to find an error in the suggested design, but also to design a better experiment. We have found this to be quite rewarding to the children, and it makes them more critical of future experimental designs. In addition, it improves their understanding of science. If you will play along with this fault during the discussion that follows, you will see this strategy in operation.

Discussion. Remind the children that they were finding out if crabs respond to light.

- On the basis of this data, ask, "How many of you think that the crabs responded to the *lamp*?"
- Then ask, "Did most of the crabs go toward it or away from it?"
- Regardless of the direction taken by the crabs, the stage is set.
- Now ask the children, "How many of you think the crabs responded to the *light*?"
- Pause while you appear to count and then ask a student who has not raised her hand, "Do you think they could have responded to some other environmental factor?"
- When some students suggest that the lamp was also very hot, you might even try to soft-pedal that idea on the grounds that "we're studying light right now—not heat."
- The children usually begin to think this through about this time, and soon you will have quite a discussion on your hands. Children who suggest that the crabs may have responded to either heat or light are correct.

The solution to the problem is to design an experiment that will separate heat from light. Suggestions involving flashlights, neon lights, and other sources of cool light are often made at this point. Encourage experiments with cool light if flashlights can be brought in the next day.

It is impossible to remove the heat from the light, but it is possible to remove the light from the heat. The following experiment, using the covered trough system, does just that.

You might let the children know how clever they were to recognize that this experiment was not properly controlled because it involved two variables—heat *and* light—instead of just one variable.

Variation. It will probably be obvious by now that all crabs did not respond in exactly the same manner. Remind the children that differences among organisms of the same kind are called variations. Crabs' responses to light are examples of variation. So are the differences in plants that were observed earlier. Ask the children to suggest other examples of the concept. Tell children that all kinds of organisms exhibit some variation. Someone might suggest examples of variations in humans, such as differences in height, weight, and the behavior of classmates.

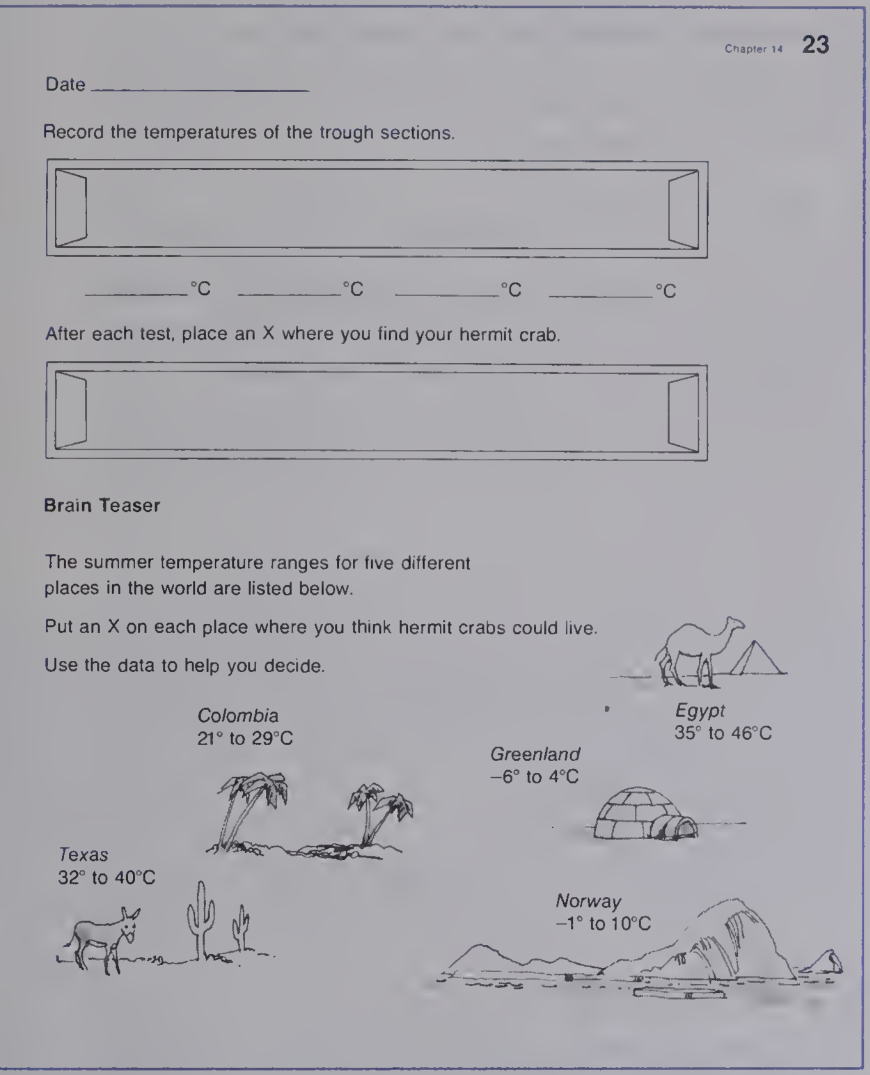
Improving the experiment. Encourage your students to improve the experimental design and to see if they can control the temperature variable. They may suggest using "cool light," such as a flashlight. They often suggest other modifications, such as using soil or sand instead of plastic as the surface; or pointing the crab in a definite direction after placing it in the center of the transparency.

Crabs and temperature. If the children mentioned that the bulb in the light experiment also produced heat, you can use that discussion to introduce the experiment with temperature. Ask them if they think that crabs respond to temperature.

The experiment. Student manual page 23 will be needed soon, and so it should be ready for use by each team. Your pupils will again work in teams of two for this experiment, using one thermometer and one crab. Have the teams set up the light/heat sources and the troughs as they did for the isopod experiments with temperature. Turn on the lamps and load the tumblers with ice and water.

Each team should also get one trough cover. The hole in the cover is not desirable for this experiment, so have the children cover each hole with any scrap of dark construction paper. The cover also prevents the crabs from climbing out of the troughs. As it may impede their movement, you may want to test only the smaller crabs or make higher, paper covers.

Using student manual page 23. After the metal strap at the bottom of the trough has become cold at one end and hot at the other, encourage the youngsters to measure the temperature at each end and at two intermediate points. Write these temperatures in the proper parts of the trough illustration on the student manual page.



Chapter 14 23

Date ____________________

Record the temperatures of the trough sections.

________°C ________°C ________°C ________°C

After each test, place an X where you find your hermit crab.

Brain Teaser

The summer temperature ranges for five different places in the world are listed below.

Put an X on each place where you think hermit crabs could live.

Use the data to help you decide.

Colombia
21° to 29°C
Egypt
35° to 46°C
Greenland
−6° to 4°C
Texas
32° to 40°C
Norway
−1° to 10°C

Let the students put the crabs in the troughs, cover the troughs, and wait about two minutes to see where the crabs go. After each trial, the students should place an X on their student manual diagram of the trough, and a dot should be placed on the class graph. Four to six trials for each crab should be sufficient, but you may allow more if interest is high. An example of a class chart is shown in Figure 14-4.

Discussion. After all data have been recorded on the chart, ask the children questions that will help them in determining the optimum temperature for crabs. Some sample questions follow:

- What temperatures did most crabs prefer?
- What temperatures did only a few crabs prefer?
- Do the class data indicate an optimum temperature for crabs?
- Did the crabs show evidence of variation in the way they responded? What did they do?

The children's responses to the brain teaser on page 23 will indicate their understanding of the optimum temperature for crabs.

Crabs and moisture. Suggest that crabs may have a preference for moisture. Encourage the children to plan an experiment that will show how much moisture crabs do prefer.

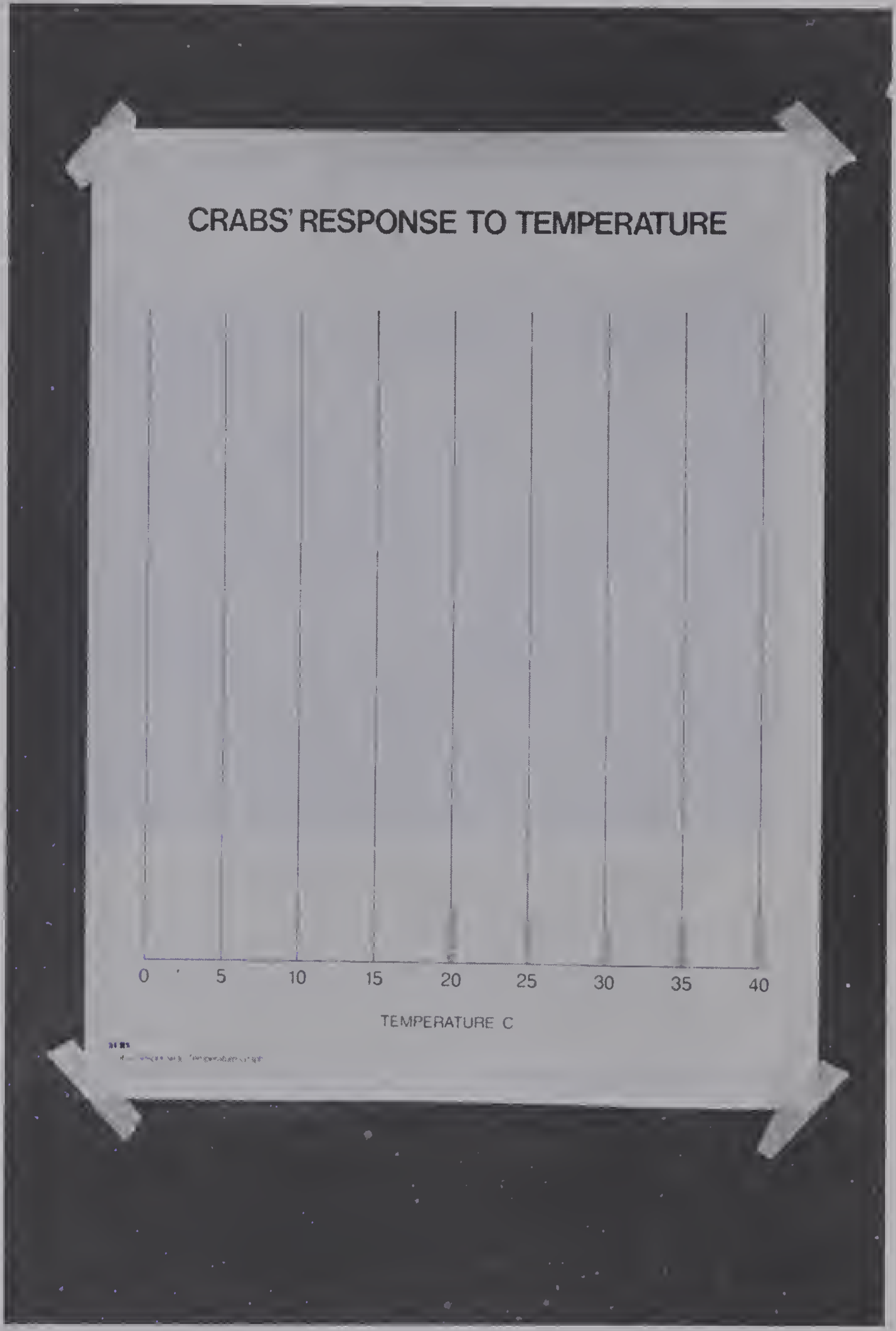


Figure 14-4. Results of the first trial.

If you are providing guidance for this activity, suggest that the children line a trough (no strap, no cylinder) with two layers of paper towels cut to fit the bottom. One half can be moistened while the other half remains dry. Insert a crab and cover the trough as in the temperature experiment.

While the children are conducting their experiments, draw the data chart shown in Figure 14-5 on your chalkboard. As the children discover which end of the trough the crabs prefer, ask them to come to the chalkboard and record an X in one of the two columns.

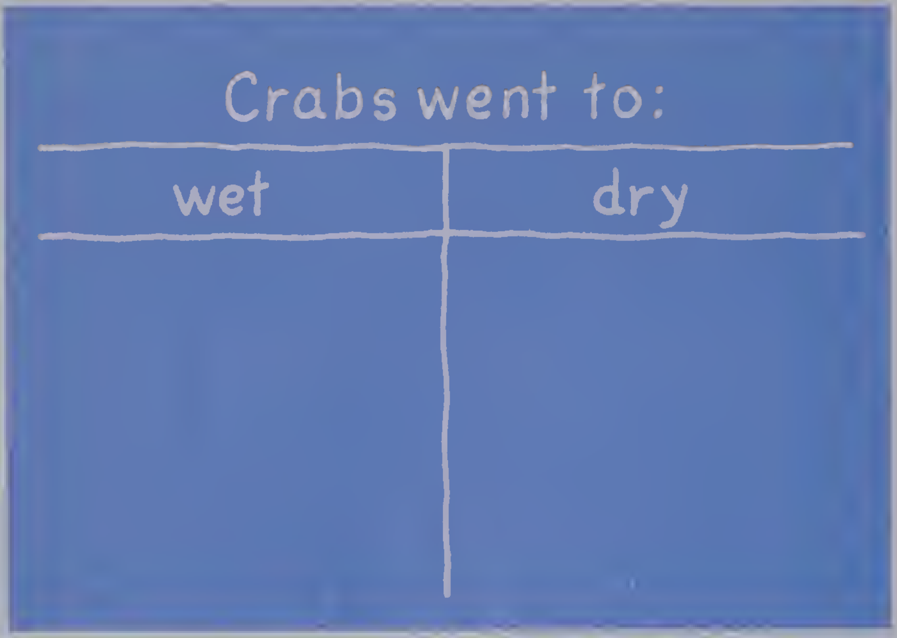


Figure 14–5. Getting ready to record the data.

Discussion: student manual page 24. Encourage a discussion of the results recorded on the data chart. What variations are there? What seems to be the optimum moisture for these crabs?

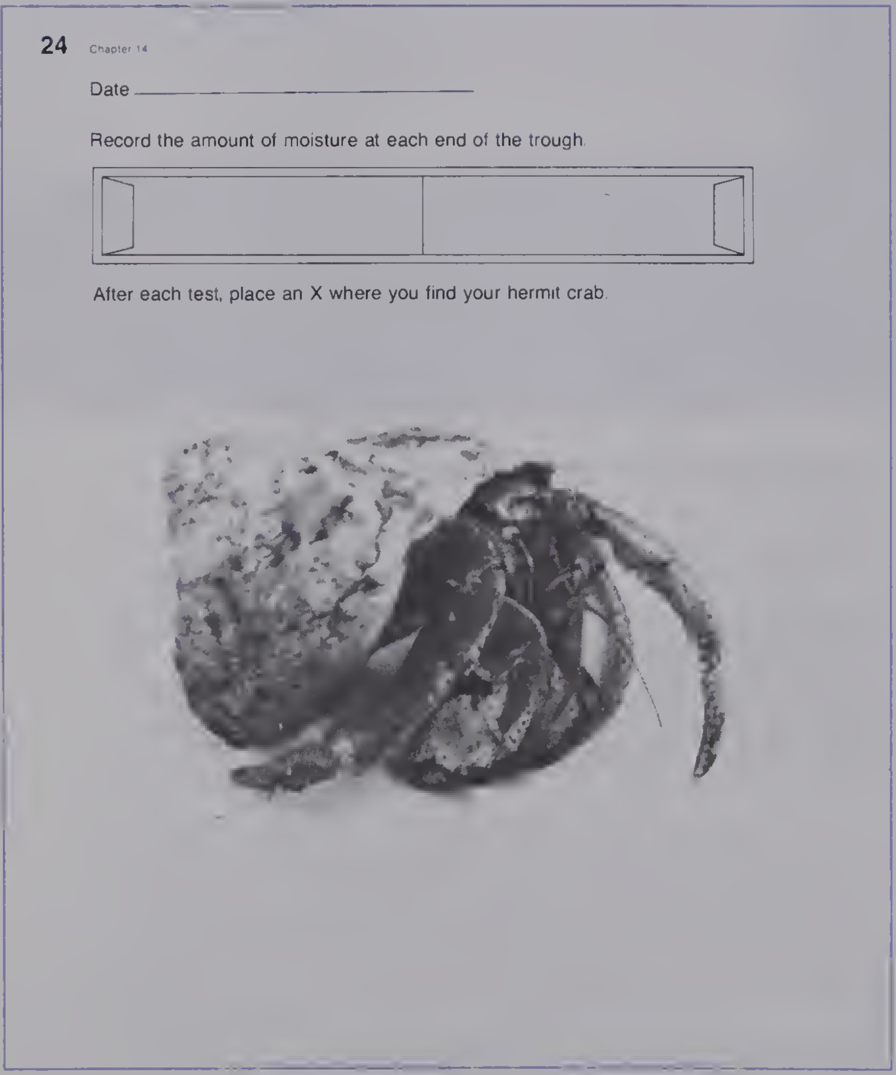
A crab's environment. Ask the children to describe the type of environment in which they think a crab should live. Let them refer to the Crabs' Response to Temperature chart, their manuals, and the transparencies, using the data to support their ideas.

What adjustments should they make in their terrariums in order to provide the best environment for their crabs? Will those adjustments affect the isopods or the beetles?

One idea that should arise from this discussion is that it is not always necessary to know an organism's response to the entire range of a factor in order to predict what its environment may be like. In this chapter, the children did not determine the optimum amount of water for crabs, for example, unless they ran additional experiments.

However, they can make inferences from the available data. For example, the children may infer that crabs must move to eat, and that they will move more slowly in a dry environment.

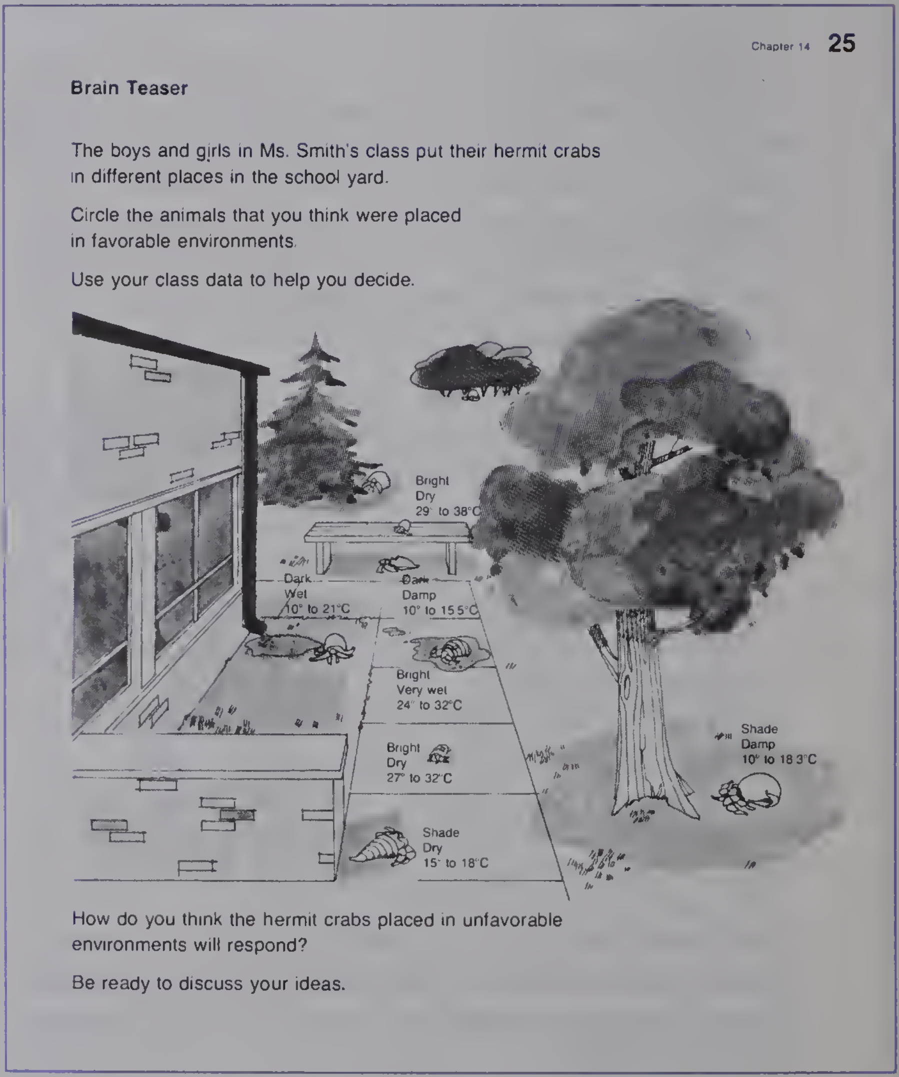
Student manual page 25. Let the children work individually on this page. A discussion of their responses


24 Chapter 14

Date ______________________

Record the amount of moisture at each end of the trough.

After each test, place an X where you find your hermit crab.


Chapter 14 25

Brain Teaser

The boys and girls in Ms. Smith's class put their hermit crabs in different places in the school yard.

Circle the animals that you think were placed in favorable environments.

Use your class data to help you decide.

How do you think the hermit crabs placed in unfavorable environments will respond?

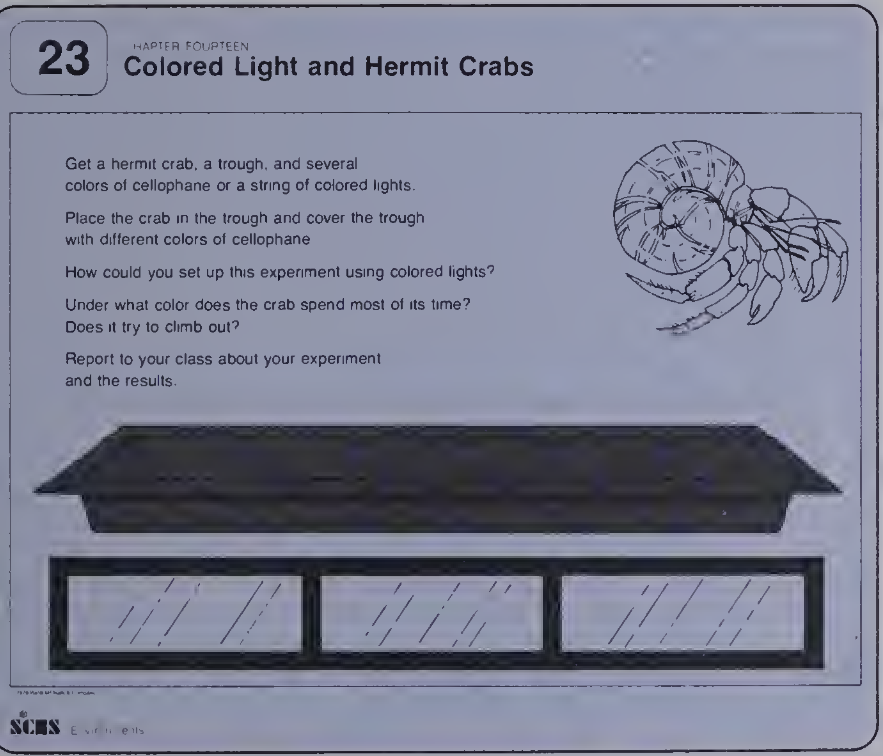
Be ready to discuss your ideas.

and the reasons for these will provide feedback on your students' understanding of the environment concept.

Note: Save the chart for use in Part Five.

EXTENDING YOUR EXPERIENCE CARDS

23. Colored Light and Hermit Crabs. This child will need to borrow some colored cellophane of various colors from the crafts teacher. If that is not available, the child should bring a string of Christmas tree lights (one string with different colors). He or she will also need a trough if cellophane is used. If Christmas lights are used, see that they are used only during the experiment (about one hour), not left burning overnight.



23
HAPTER FOURTEEN
Colored Light and Hermit Crabs

Get a hermit crab, a trough, and several colors of cellophane or a string of colored lights.

Place the crab in the trough and cover the trough with different colors of cellophane.

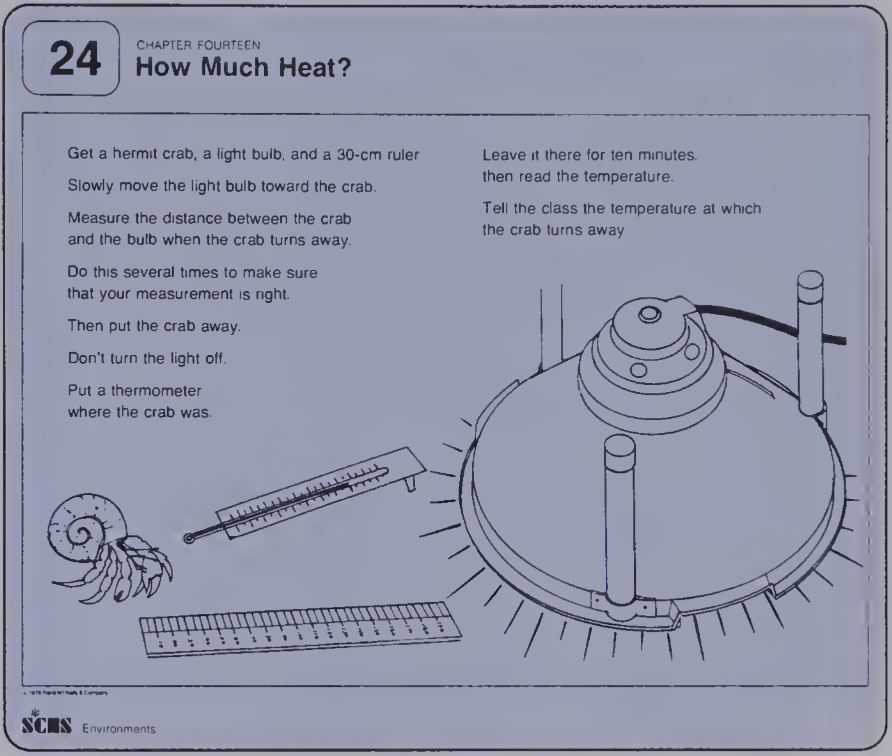
How could you set up this experiment using colored lights?

Under what color does the crab spend most of its time? Does it try to climb out?

Report to your class about your experiment and the results.

SCIS Environments

24. How Much Heat? The student selecting this card will require the use of one of the lamps, his or her own crab, a thermometer, and a ruler.



24
CHAPTER FOURTEEN
How Much Heat?

Get a hermit crab, a light bulb, and a 30-cm ruler.

Slowly move the light bulb toward the crab.

Measure the distance between the crab and the bulb when the crab turns away.

Do this several times to make sure that your measurement is right.

Then put the crab away.

Don't turn the light off.

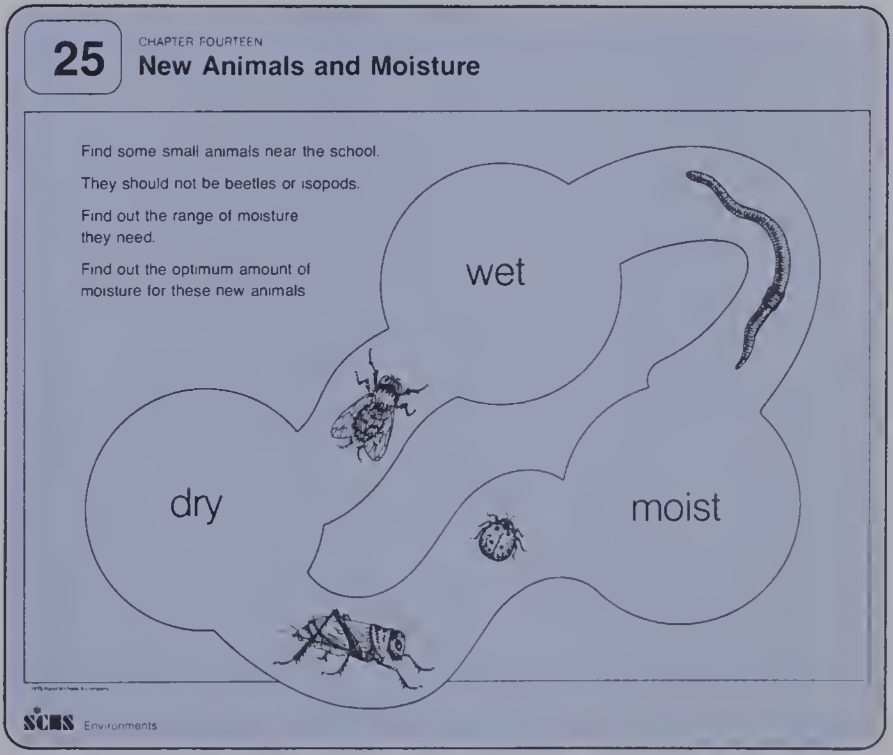
Put a thermometer where the crab was.

Leave it there for ten minutes, then read the temperature.

Tell the class the temperature at which the crab turns away.

SCIS Environments

25. New Animals and Moisture. Youngsters planning to use this card will need to bring in a different kind of animal from outside. They will also have to be able to design an experiment to determine how much moisture that animal needs.



25
CHAPTER FOURTEEN
New Animals and Moisture

Find some small animals near the school.

They should not be beetles or isopods.

Find out the range of moisture they need.

Find out the optimum amount of moisture for these new animals.

SCIS Environments

15

The Environment of Beetles

SYNOPSIS

Children design controlled experiments to determine the beetles' responses to such environmental factors as light, temperature, and moisture.

Suggested time: ***four to six class sessions, depending upon the children's ability to design and carry out experiments***

TEACHING MATERIALS

For each child:

student manual pages 26–29

The necessary equipment will vary depending on the experiments the class designs, but will probably include the following:

TEMPERATURE AND LIGHT TESTS:
For the class:

- 50 beetles
- light/heat sources (assembled in Chapter 8)
- dark construction paper*
- rocks*
- felt pens or crayons*
- scissors*
- tape*
- soil‡

Drawer 1

- chart paper

Drawer 2

- plastic troughs
- trough covers
- metal straps

Drawer 3

- metal cylinders
- labels
- adhesive dots

Drawer 4

- thermometers

WATER TEST:
For the class:

- 50 beetles
- tape*
- paper towels*

Drawer 1

- chart paper

Drawer 2

- plastic troughs
- metal straps

Drawer 3

- adhesive dots

Drawer 4

- water sprinklers

* provided by the teacher
‡ Sand and Soil box

TEACHING SUGGESTIONS

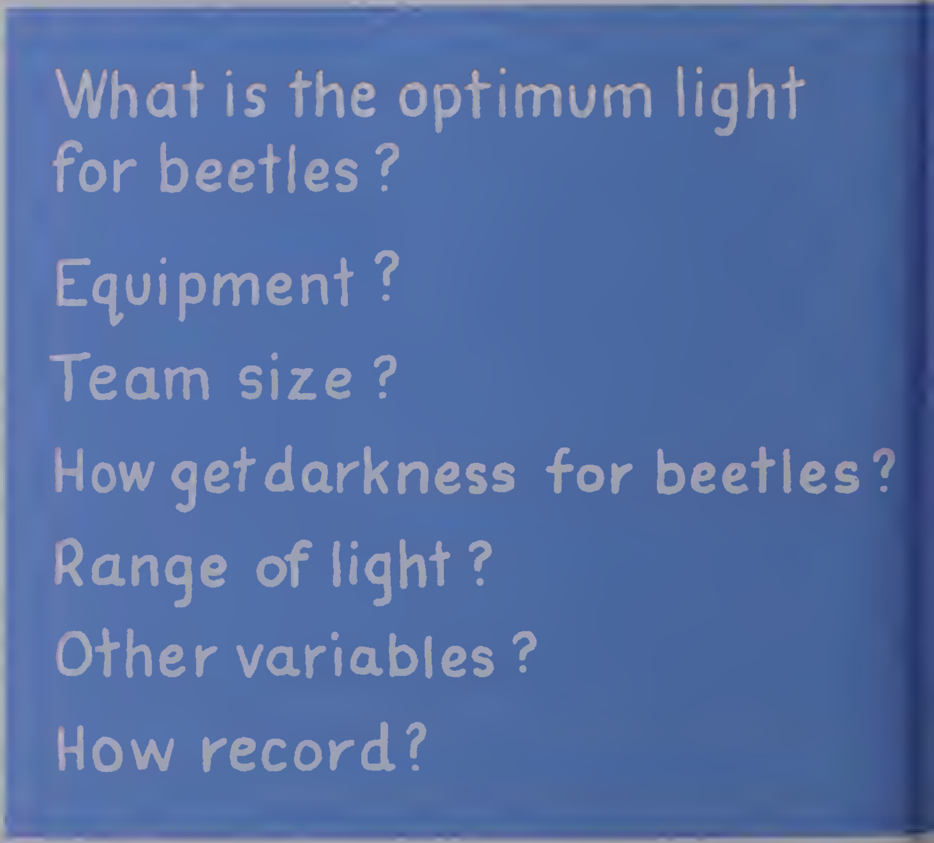
These activities continue the discovery parts of the learning cycles for *range* and *optimum;* the children apply their previous experiences and their new knowledge of experimental design to a new organism, a beetle.

By the time your students reach this point in *Environments,* they should begin designing their own experiments based on their previous experiences. In this chapter, they have a chance to propose, design, and carry out their own experiments. Your role is to help the children choose one or two experimental designs that will help them answer questions.

Beetles and light. Write the question "What is the optimum light for beetles?" on the chalkboard. As your pupils discuss their experimental designs, they should also discuss some of the following problems:

- What equipment can we use?
- How many light/heat sources are available?
- How many of us should work together?
- How large and how high must a container for these beetles be?
- How can we make it dark for the beetles?
- How can we provide a range of light intensity?
- How can we control all other variables except light?
- How shall we record the data?

Figure 15-1. Stating the problem and establishing guidelines for the experimental design.



What is the optimum light for beetles?

Equipment?

Team size?

How get darkness for beetles?

Range of light?

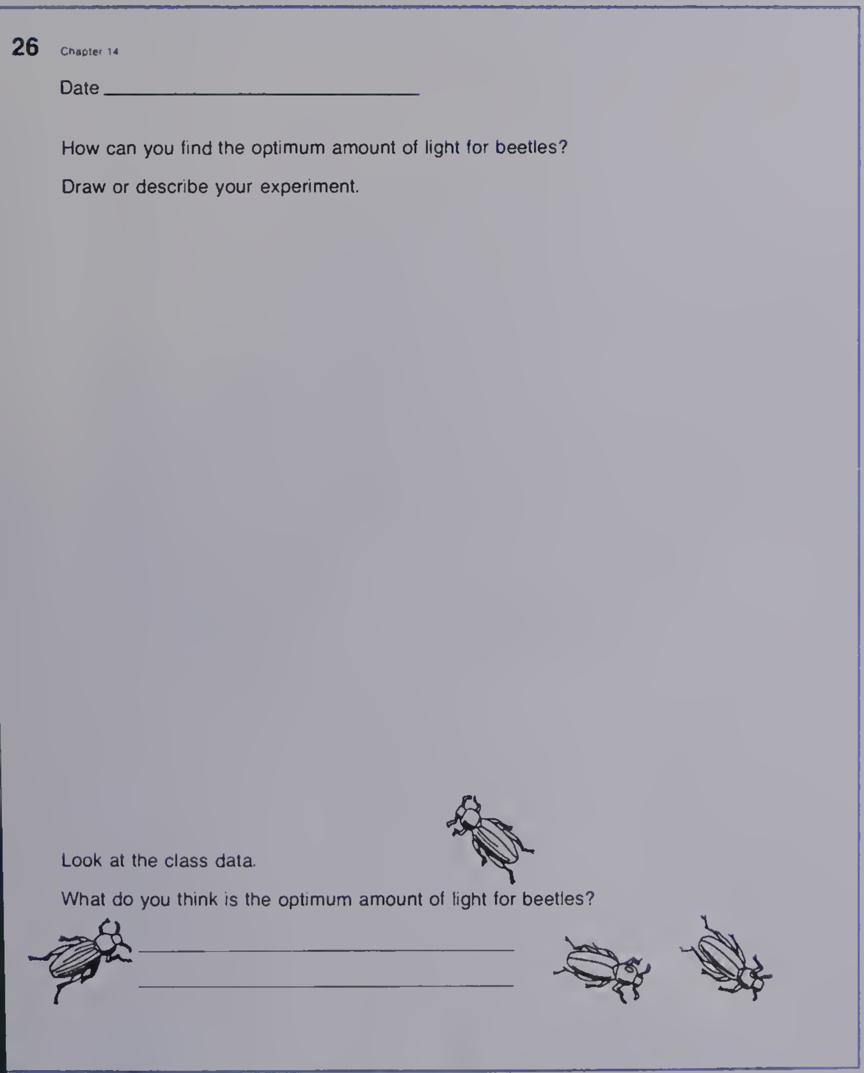
Other variables?

How record?

The experiment. The children will be interested in getting started on their experiments as soon as possible. This interest may diminish if they are very much delayed. If the children have not decided on several experimental designs in about ten minutes of discussion, release them to think individually, using their hands and selected equipment. Activities such as handling the beetles, making beetle habitats with light and dark rooms, and noticing where the beetles crawl trigger the imagination. Experimental designs and some data will emerge from such preliminary investigation. During the experiments or while in conversation with you, the children may notice and correct some of their design flaws.

After the experiments are completed, return the beetles to the classroom container.

Data: student manual page 26. Ask the children to draw or describe their experiments. This information should be useful as the class constructs a chart. The chart can be similar to the illustration, or you and the children may prefer to design your own. Save the chart for use at the end of this chapter and in Part Five.



26 Chapter 14

Date ____________________

How can you find the optimum amount of light for beetles?

Draw or describe your experiment.

Look at the class data.

What do you think is the optimum amount of light for beetles?

____

____

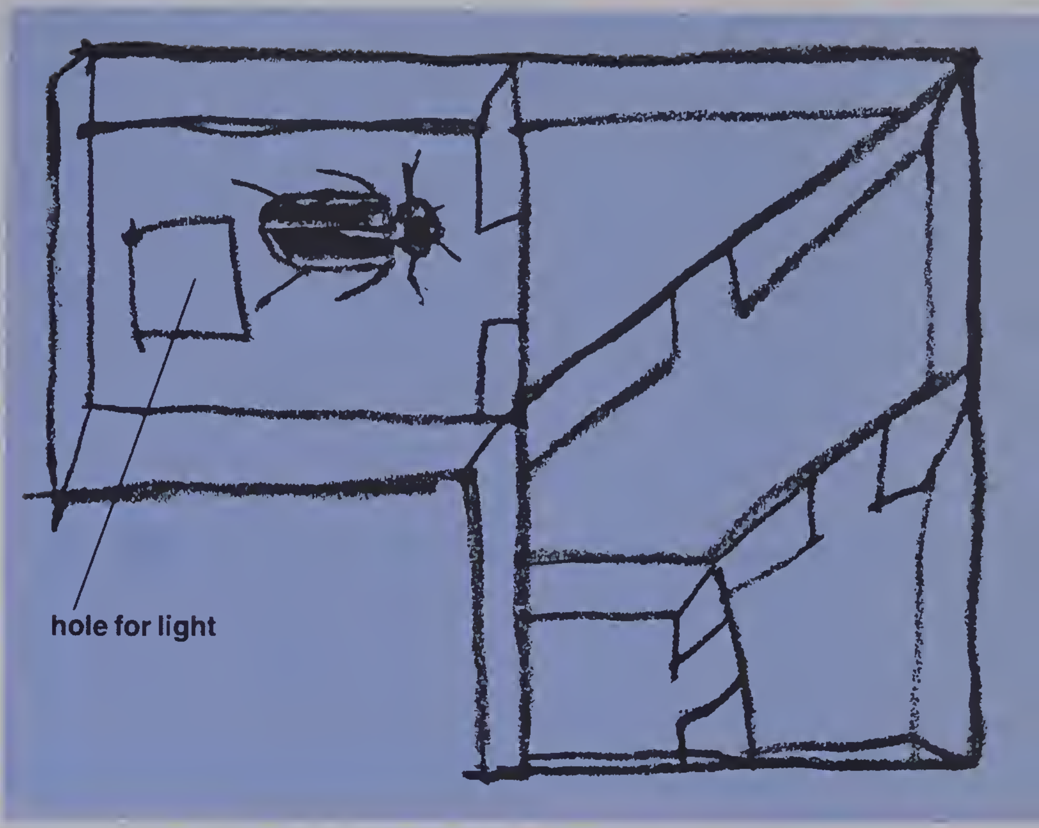
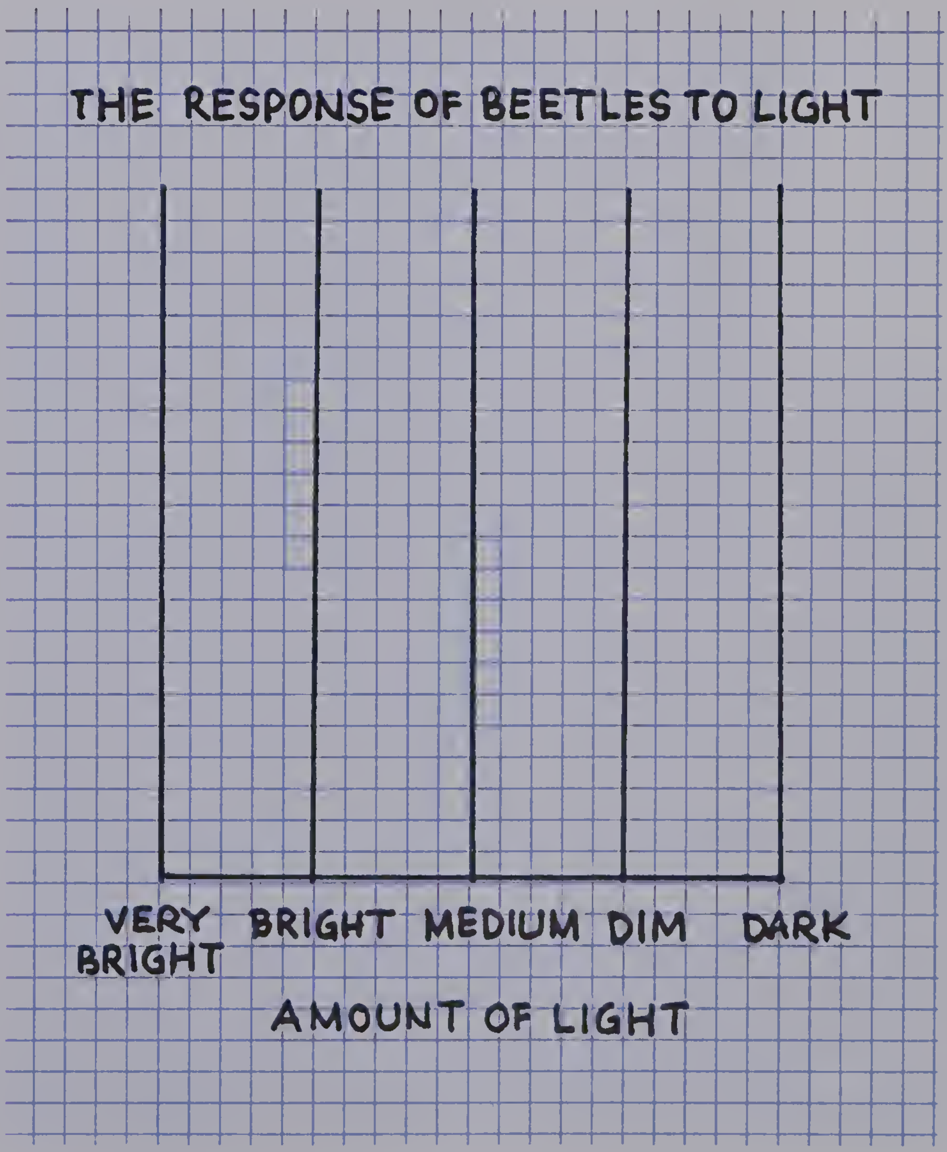


Figure 15–2. Beetle habitat (top removed) designed by a child.

Figure 15–3. Example of a chart to be used as a class record.



Discussion. Let each team describe its experiment and report the data collected. The data may show that beetles go to both dark and light areas. If that is the evidence and the children trust their experimental designs, then that is the answer to the original question. During the discussion, however, children may mention variables that were not controlled in a particular team's experiment. Encourage this kind of analysis, and if the children decide they can't trust their designs, encourage them to improve their experiment and to conduct additional tests. Children often improve in their ability to solve problems by carrying out this kind of activity.

Beetles and temperatures. Your students will design techniques for investigating the response of beetles to temperature. They may wish to use troughs, sand, or something else to better meet their own requirements.

To help the children design testing techniques, follow the same approach you used in the light experiment. As the children offer suggestions for experiments, be alert to comments that will give you feedback about their ability to design an experiment and their understanding of the range and optimum concepts. Teams should discuss ways of providing a temperature range and the number of tests they feel are necessary to produce reliable data. They should also be concerned about controlling variables, such as how and when to take temperature readings, where to start the beetles in the experiment, and how to keep the amount of light constant.

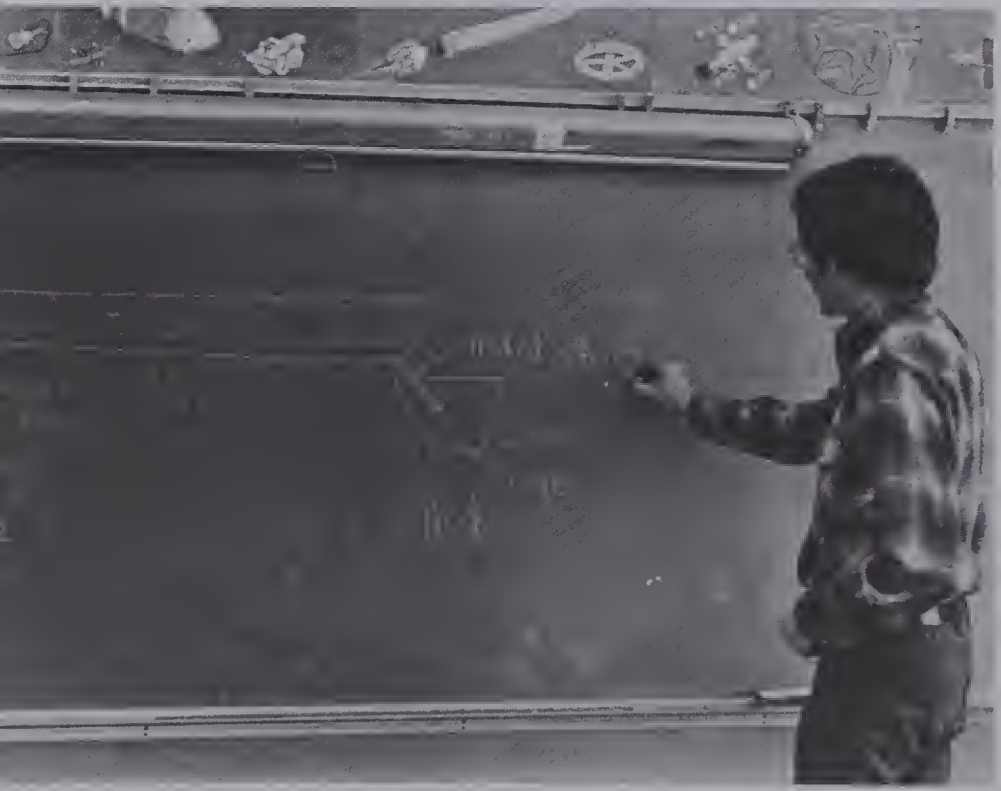
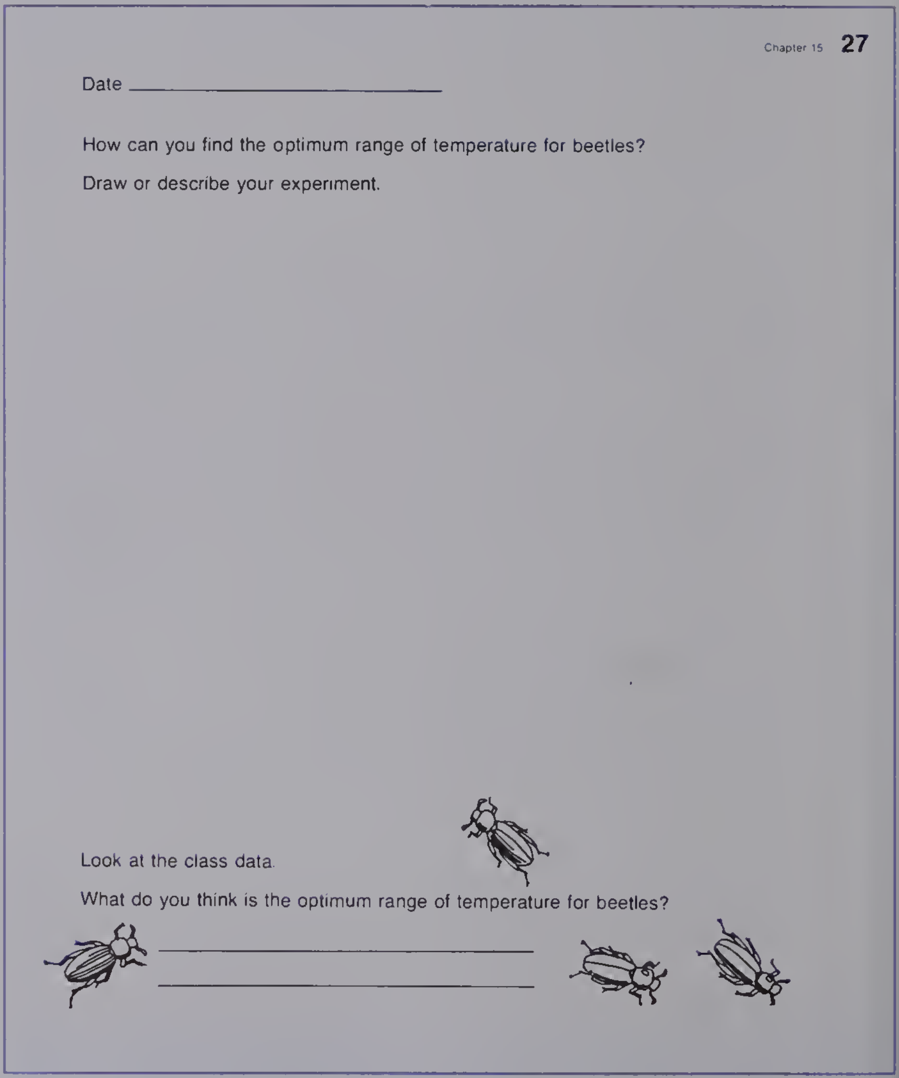


Figure 15-4. One design for determining beetles' responses to temperatures.

Data: student manual page 27. A method of recording the information obtained should be included in the experimental design. You may wish to have the children include this as part of their experiment description. A class chart, similar to the charts used in the isopod and snail experiments, should also be devised. Save the class data for use at the end of this chapter and also in Part Five.



Chapter 15 27

Date ______________________

How can you find the optimum range of temperature for beetles?

Draw or describe your experiment.

Look at the class data.

What do you think is the optimum range of temperature for beetles?

____

____

Discussion. The children can use their student manuals to help them report their experiments and the data they collected. Ask the children if they can determine the optimum temperature for beetles from the class data. While you observed the groups conducting their experiment, you may have noticed that some of the children did not provide a range of temperatures or control certain variables. You may have to ask a few questions to initiate a discussion about these problems if the children do not do so.

- If a team did not provide their beetles with a range of temperatures, you might ask them how they knew that beetles did or didn't prefer that one temperature if it couldn't get away from one temperature to another one.
- If a team used unshaded light as the source of heat, tell them you think the beetles went (away, toward it) because they responded to *light,* not *heat.* If the children cannot defend their experimental design, they should correct it and redo the experiment.

Beetles and moisture. As the teams attempt to design experiments to test the response of beetles to different amounts of moisture, you may find them speaking only of "wet" and "dry" rather than in terms of a range of water. Refer them to previous experiments, leading them to include the idea of range in their design.

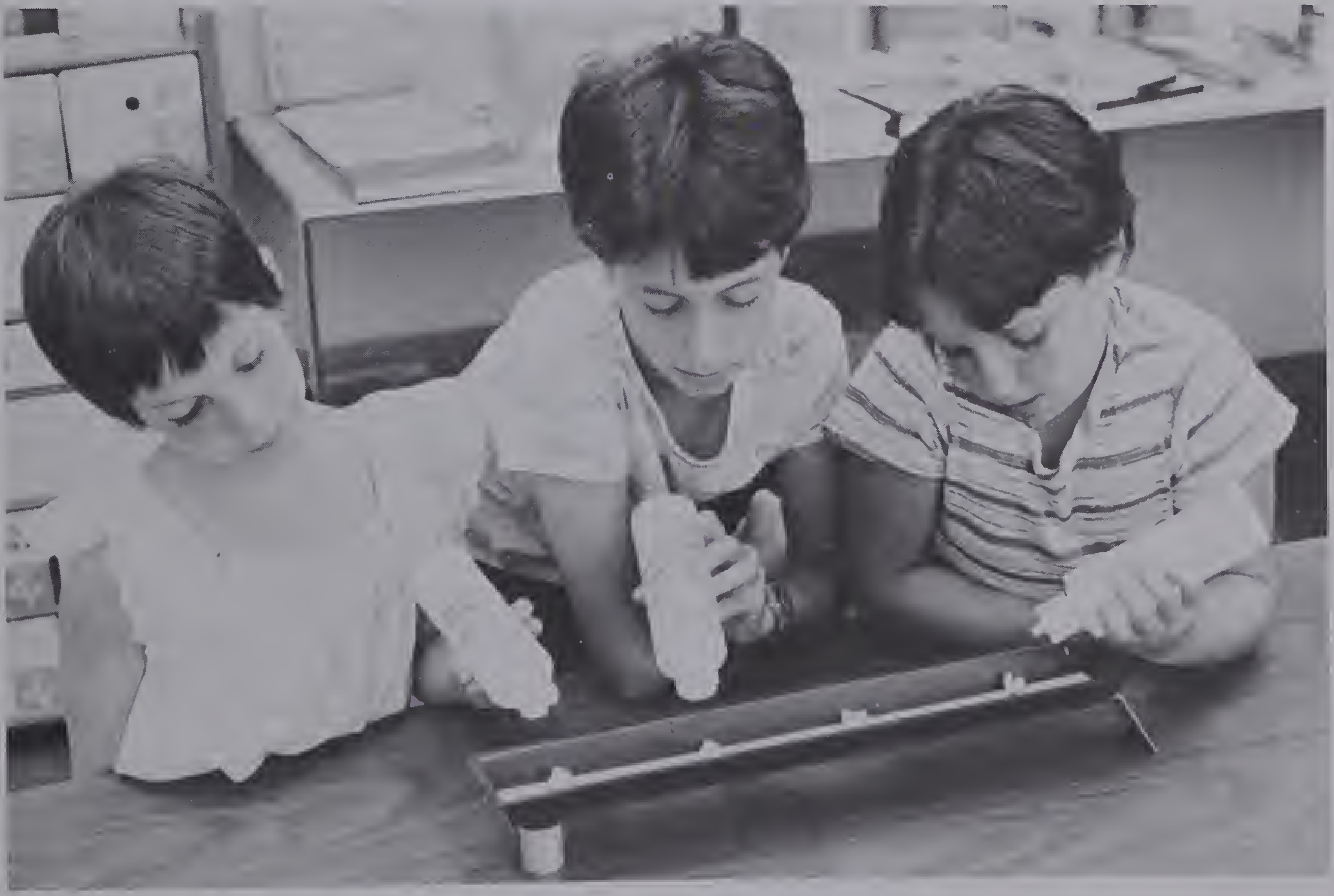
The following simple test provides a means for investigating a range of water. It is presented here as a guideline for children wishing to design their own experiments.

1. Place a crumpled piece of paper towel at four different positions in the trough. Using a sprinkler, leave one piece dry, make one damp, another wet, and soak the fourth (be careful not to drip water between the towels or to get a slightly moist towel wet).
2. Place at least five beetles in the center of the container. Wait about ten minutes before recording the positions of the beetles.

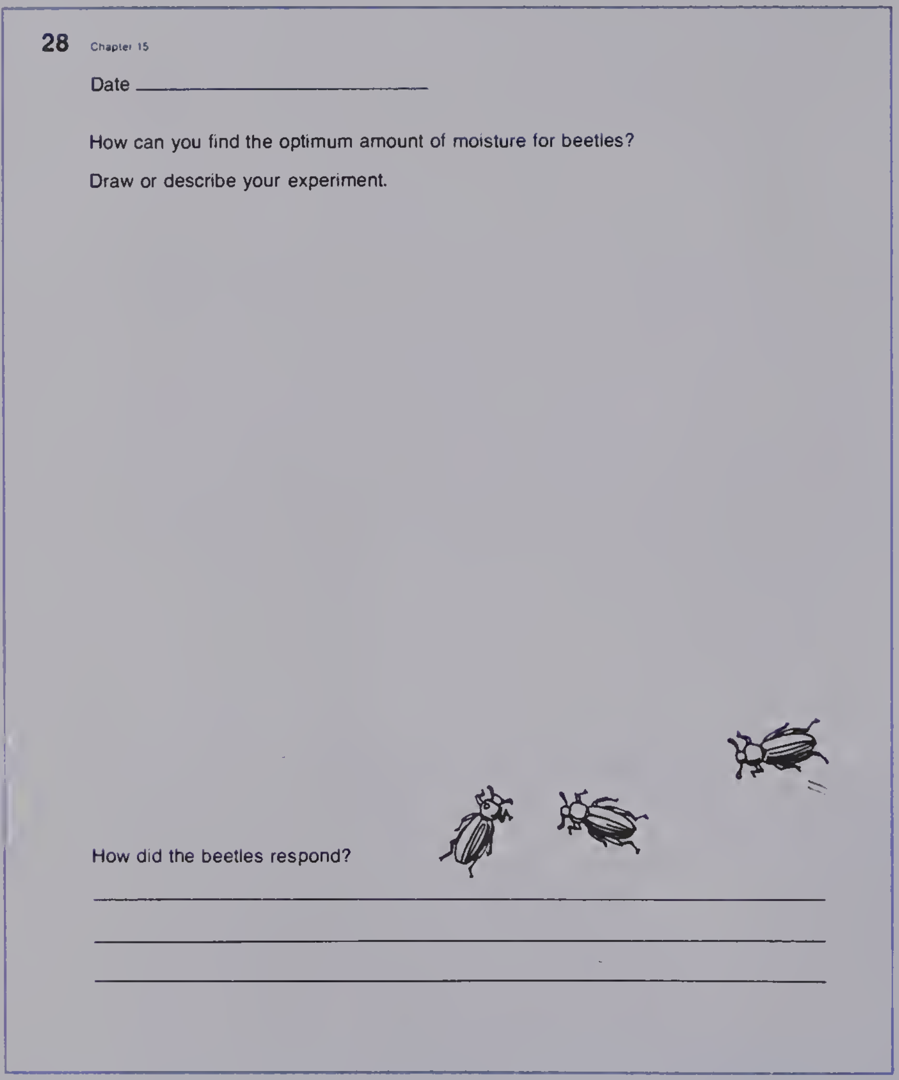
A chart similar to that used in the isopod water test (page 68) can be used for recording the results.

When the experiments are completed, return the beetles to the classroom container. These organisms will be used again in Part Five.

Figure 15–5. The setup for testing beetles' response to moisture.



Discussion: student manual page 28. The children should describe their experimental design and their results. Encourage them to discuss the results of their tests. Ask if the data show any evidence of variation in the beetles' responses and if there seems to be an optimum amount of water for beetles. Children may want to compare the water requirements of beetles, isopods, and snails.



28 Chapter 15

Date ____________________

How can you find the optimum amount of moisture for beetles?

Draw or describe your experiment.

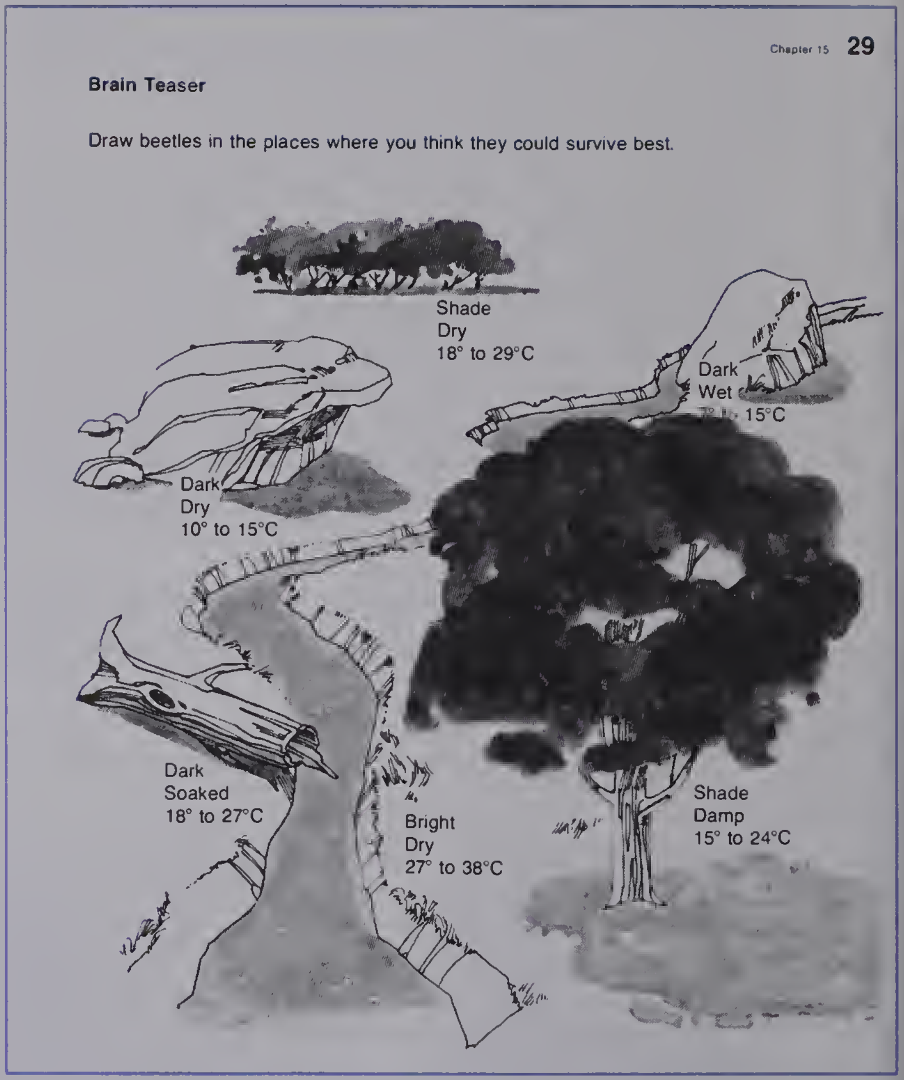
How did the beetles respond?

____

____

____

A beetle's environment: student manual page 29. Display all the data collected during the beetle experiments. Ask the children to suggest what a beetle's environment might be like, basing their comments on their data. Then let the children work individually on this page.



Chapter 15 29

Brain Teaser

Draw beetles in the places where you think they could survive best.

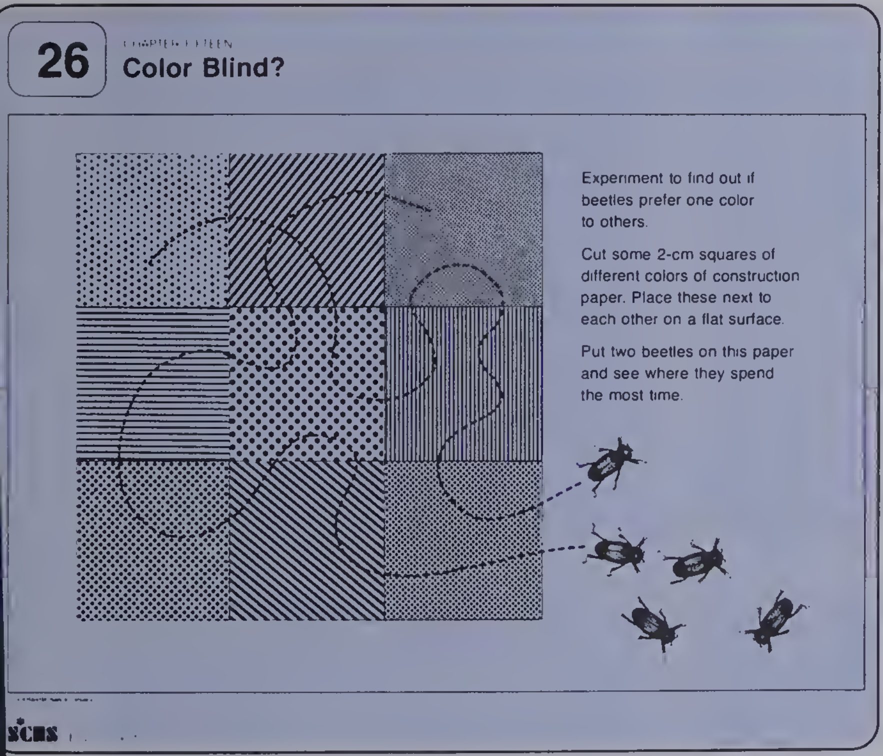
OPTIONAL ACTIVITIES

Other life cycle stages. The children may wish to test the responses of other stages in the life cycle of the mealworm beetle. There probably are larvae and pupae in your classroom mealworm culture that can be used in experiments. These should be tested separately from the adults. The results of these tests could be compared with tests on responses to environmental factors during different stages in a plant's life cycle.

Response to gravity. An environmental variable not yet tested is gravity. Do beetles tend to go against it (up) or with it (down)? Inclined troughs with masking tape or a thin layer of sand sprinkled over rubber cement on the bottom of the trough will provide a surface to which the beetles or larvae can cling.

EXTENDING YOUR EXPERIENCE CARDS

26. Color Blind? Children selecting this card will need some scraps of construction paper—one piece each of as many colors as possible. They will also need two beetles.



26

CHAPTER FIFTEEN

Color Blind?

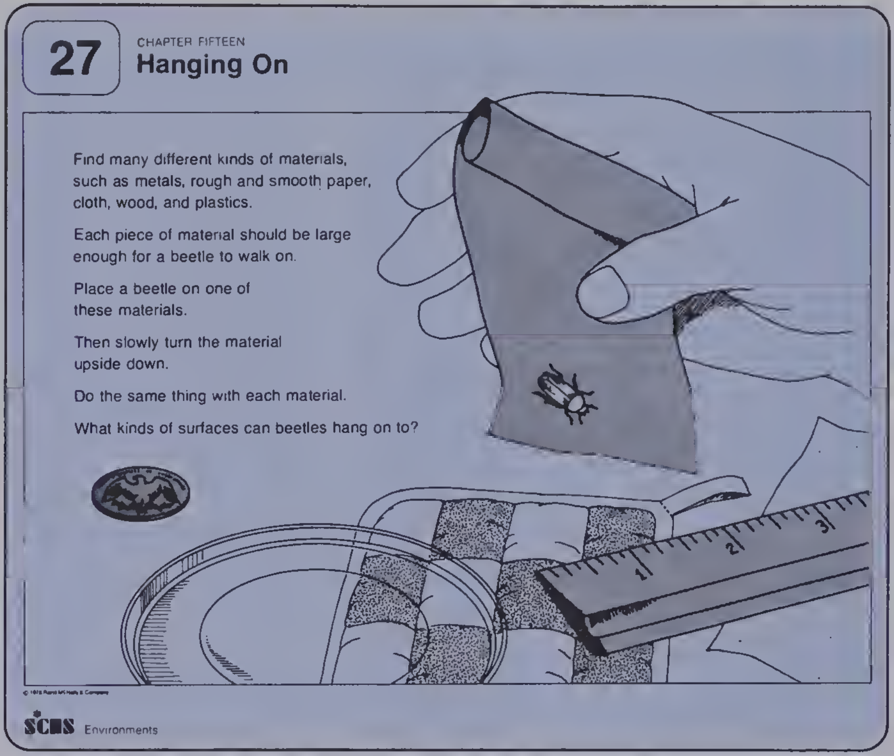
Experiment to find out if beetles prefer one color to others.

Cut some 2-cm squares of different colors of construction paper. Place these next to each other on a flat surface.

Put two beetles on this paper and see where they spend the most time.

SCIIS

27. Hanging On. A child selecting this card will need to collect objects of different textures. An excellent source for this variety is the SCIIS *Material Objects* kit. These objects vary in color as well as in texture; children doing cards 26 and 27 should find it helpful to discuss their results.



27

CHAPTER FIFTEEN

Hanging On

Find many different kinds of materials, such as metals, rough and smooth paper, cloth, wood, and plastics.

Each piece of material should be large enough for a beetle to walk on.

Place a beetle on one of these materials.

Then slowly turn the material upside down.

Do the same thing with each material.

What kinds of surfaces can beetles hang on to?

SCIIS Environments

CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's ability to interpret environmental-factor data and to make predictions from it, turn to page 99 of the evaluation section at the back of the guide.

Part Five

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The Total Environment

OBJECTIVES

To describe similarities and differences in the responses of plants and animals to changes in environmental factors.

To use experimental data when planning the construction of a terrarium.

To construct a terrarium that provides optimum ranges of environmental factors for certain kinds of animals.

To plan a human environment which considers the requirements of other organisms.

BACKGROUND INFORMATION

The total environment, all of the abiotic and biotic environmental factors which affect any one organism, is a complex arrangement of interdependent parts. For example, the intrusion of a bear into an area affects plants which are stepped on, tree and bush branches which are broken, small animals which are killed by the bear whether it walks on beetles or preys on a fish, fleas and ticks which can now use the bear as a source of food, and the young plants not stepped on but fertilized by the bear's feces. The dead plant materials from the bear's visit no longer provide shade and increase the amount of food on the ground; plants which need light to grow may not be able to do so; the sloshing about by the bear during its fishing maneuvers provides water to seeds which may now grow; an ant nest is rendered unusable now because of the bear-induced flood and the compressed earth near the stream, thus removing ants as a food supply for their predators; and a few more fleas and ticks can now survive to carry Rocky Mountain spotted fever and bubonic plague to both affect and infect other animals.

Far from a simple consideration of the effect of a certain amount of light on a plant, we can now realize how variable the amount of light is and that it is quite dependent upon the many unpredictable events which occur naturally, even regularly. No one will ever know why this hypothetical bear decided to visit that one area on that day. It could easily be attributable to the lightning-felled tree blocking its normal path to the Camp 12 garbage can.

In ways similar to the events surrounding the bear, humans too are subject to changing environmental conditions. Before the era of technology, humans were subject to radiation from the naturally radioactive elements in the earth, but because they lacked technology, were not aware of it. However, now that we have many of the tools and instruments to detect everything from minute traces of gases in the atmosphere to the amount of cancer-causing ultraviolet light reaching us from the sun, we can better assess both the problems we create for ourselves and for other organisms upon which we depend for life.

Figure V–1.

Instead of looking only at the simple effects of one environmental factor on one organism, humans are now looking at the effects of various combinations of these variables. They are also realizing that while stepping on an ant colony isn't likely to result in catastrophic food shortages for the world, using certain poisons to kill unwanted crop eaters so we can have more food may very well kill the bees that pollinate the very crop we are trying to save. The use of Freon for everything from refrigeration to propellants for atomizing liquids, an apparently safe practice only a short time ago, may so change our optimum ultraviolet light environmental factor as to harm millions of organisms.

OVERVIEW

In order to help children understand that many different factors must be considered when establishing a proper environment, they design and prepare such an environment for several organisms in Chapter 16, "Building a 'Perfect' Habitat." In Chapter 17, "The Human Environment," students discuss and plan a human environment which considers at least a few of the other organisms upon which humans are dependent. During this planning, children find they cannot neglect the environmental factors of organisms other than humans if humans are to survive.

16 Building a "Perfect" Habitat

SYNOPSIS

Children plan and construct a habitat which possesses the proper range and optimum environmental factors for the organisms they select.

Suggested time: *one session to plan and construct the habitat, one session to modify it and intermittent attention over a two-week period*

TEACHING MATERIALS

For each child:

student manual pages 30 and 31

For the class:

The children may decide to use any of the organisms and the materials in the kit, the most important being:

- charts and graphs (from previous chapters)
- land hermit crabs
- isopods
- beetles
- light/heat sources (assembled in Chapter 8)
- tape*
- soil‡
- local organisms§
- containers to be used as extra terrariums§

Drawer 2

- plastic troughs
- trough inserts
- metal straps

Drawer 3

- seeds

Drawer 4

- container lids
- water sprinklers
- thermometers

Drawer 5

- six-liter containers

* provided by the teacher
‡ Sand and Soil box
§ provided by the children

TEACHING SUGGESTIONS

In this chapter and the next one are discovery experiences for all the learning cycles in the unit.

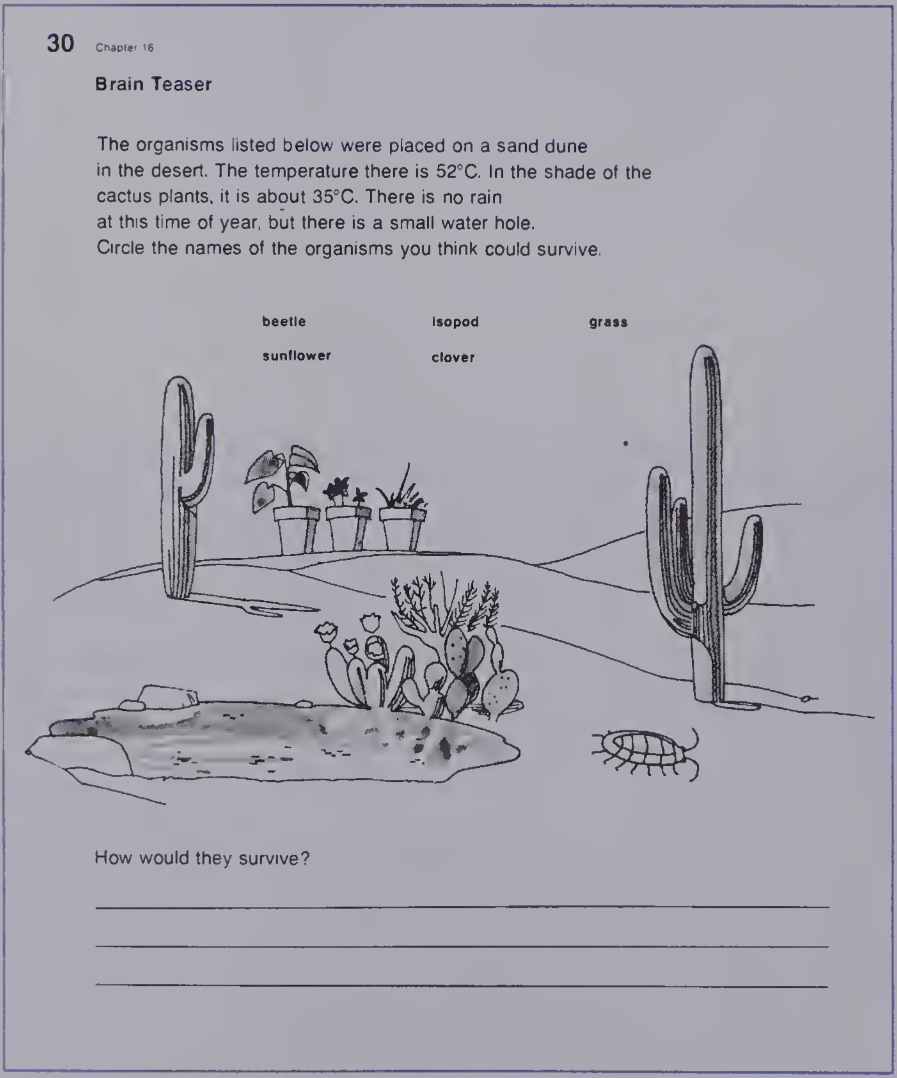
Challenge the children to select some of the plants and animals they have been working with, or even some other local organisms, and prepare a habitat that will be "just right" for the organisms they select. Tell them they can use as many or as few organisms as they want to, but the habitat and its environmental variables should be so good for the organisms that they will live in the habitat for two weeks without any care at all after the habitat is constructed.

The children may have some questions at this point. You can modify the learning situation as you deem advisable for your particular situation, but retain the goal of producing a habitat possessing all the proper optimum environmental factors for each of the organisms for a two-week period. The children can select fewer organisms, use local ones, use containers other than the 6-liter terrariums, provide food, develop a watering system, and carry out the many other ideas they will have, but keep the challenge. Before starting the planning and construction, discuss with the children some differences in how plants and animals responded to various environmental factors investigated in this unit. You may wish to record on the chalkboard their ideas about the responses of different organisms to one or more of the factors, as in Figure 16-1.

Figure 16-1. Reviewing some responses to light.

The children should mention two basic differences in the responses of plants and animals to environmental factors: (1) plants are unable to move toward or away from a particular intensity of a factor (except by growing) and, therefore, are able to respond only by growth changes; and (2) animals respond quite rapidly because they can move toward or away from a certain condition. (An interesting discussion may result from the question, "Do animals move toward a favorable intensity of a factor or away from an intensity that is less favorable?") Children may also suggest that different kinds of plants or animals respond differently to the same intensity of an environmental factor.

Using student manual page 30. A problem in which now-familiar organisms are placed in a desert is presented on this page. The children's answers to this problem will give you feedback about their understanding of plant and animal responses to environmental factors. Discuss this page with the children and encourage their speculation.



30 Chapter 16

Brain Teaser

The organisms listed below were placed on a sand dune in the desert. The temperature there is 52°C. In the shade of the cactus plants, it is about 35°C. There is no rain at this time of year, but there is a small water hole. Circle the names of the organisms you think could survive.

beetle isopod grass

sunflower clover

How would they survive?

____

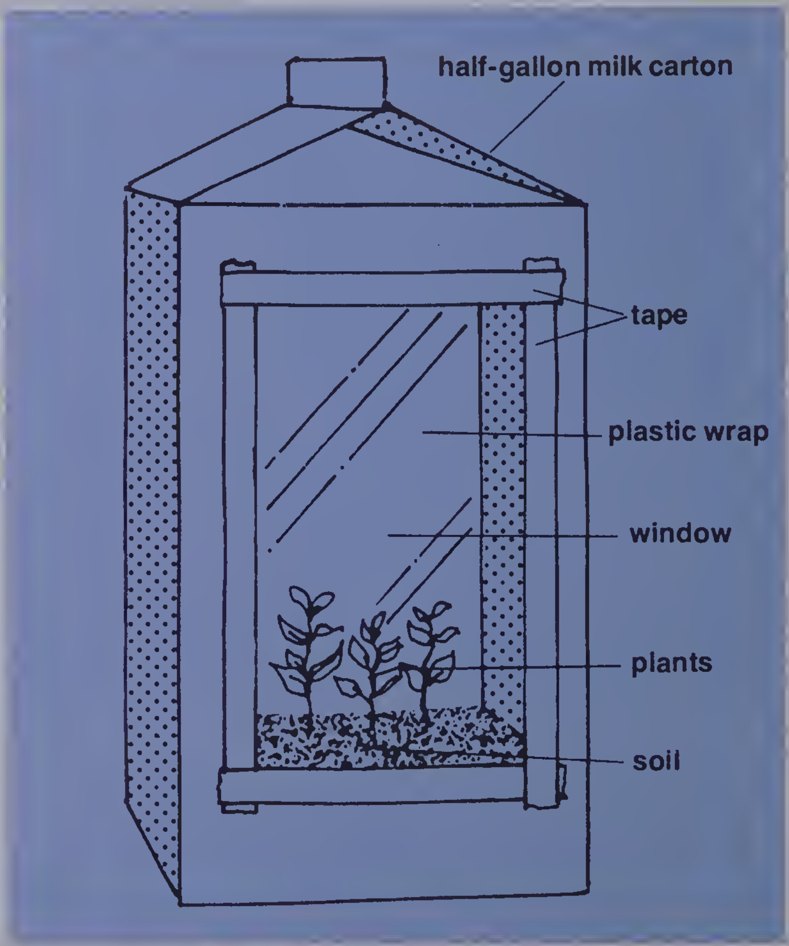
____

____

Reviewing the data. Display the charts from the previous chapters. Keep the charts for each organism together so the children may easily refer to them. You may wish to go over some of the charts and student manual pages in order to review the children's findings. Explain to your students that they will build environments for organisms they used in earlier experiments. Using the experimental results, each team should choose a group of organisms that can live together. (Some may select organisms that survive in warm, dry conditions. Others may select organisms that live in a cool, damp environment.) They should design the terrariums so these organisms can survive for two weeks. Also explain to the students that they may use other organisms such as those found locally if they wish.

Organizing the class. Some of the children may wish to work by themselves while most will probably want to work in teams of various sizes. The prime objective is to help the children to think through the needs of their selected organisms and to be able to carry out their plans. If more than three students work together on this design, our experience suggests that at least one of them will not contribute very much. The use of other types of containers such as milk cartons, old school aquariums, cardboard boxes lined with clear plastic wrap, etc., will extend the available 6-liter containers and allow fewer children per container. After the teams are established, the children may make their plans.

Figure 16-2. A homemade terrarium. The animals can be added through the pouring spout, which can then be refolded.



Building terrariums: student manual page 31. Encourage the children to work in teams of two or three so each child can actively participate in planning and building his team's terrarium. Have them record their experimental plans on this page. As you talk to individual teams and review these plans, you can obtain feedback about how well the children seem to understand the results of their previous experiments and how much they rely on the data.

Allow your students time to collect the materials and organisms they have decided to use. It is difficult for children of this age to keep in mind what they have planned to do. Very often a child becomes so engrossed in handling materials that she forgets her carefully prepared plans. Questioning a child about what she is doing may remind her.

Observing the terrariums. After teams construct their terrariums, allow them to place these anywhere in the classroom. Over the next week, allow your students time to informally observe and maintain the terrariums. Schedule discussions as often as possible so the children can evaluate how well they have built the environments. If, during that week, a team decides that the conditions it tried to produce have not been achieved, encourage them to fix the terrariums. Have the children describe or draw their changes on student manual page 31.

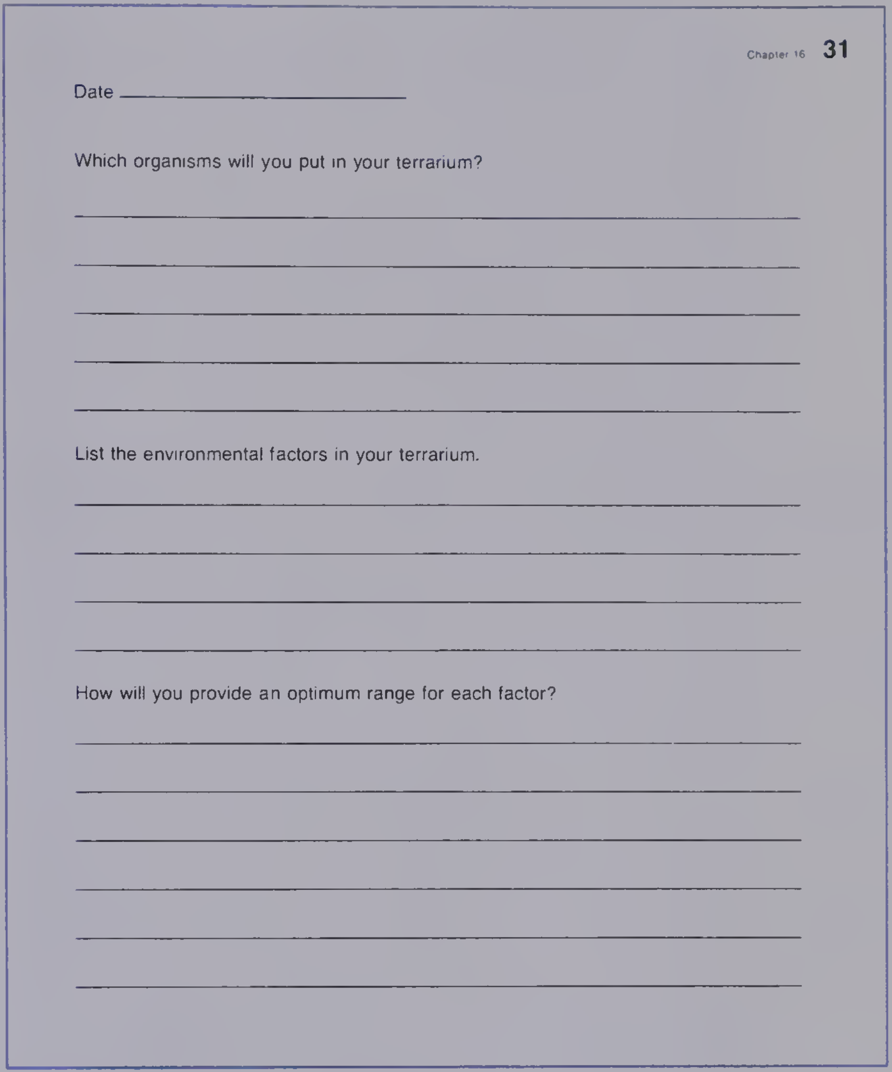
As you discuss with your pupils reasons for alterations, you should obtain feedback concerning their understanding of the previous experiences in the unit.

The two-week trial. After the children think they have prepared the habitats in such a way that optimum environmental factors are present, start the two-week trial period. It is more fun if all the teams are able to begin at the same time, but it is all right to stagger the starting periods.

Once begun, the trial period should not be interrupted unless the team thinks their organisms are in dire peril. From time to time, have each team display their habitat so all may view how everyone else's terrariums are doing.

When the time period you have set is up, arrange a final review session before having the students open and check their terrariums. Line up all the habitats and have each team explain how their terrariums fared during the two-week period without any outside assistance. Did they provide the optimum conditions? Did the organisms respond favorably? Did anyone forget to plan for one of the necessary environmental factors? Which factors were not right for the organisms which did not fare well? Do these same kinds of problems happen outside?

Do not evaluate the children's problem-solving abilities in terms of organism survival, since death may result from causes other than environmental factors.



Chapter 16 31

Date ____________________

Which organisms will you put in your terrarium?

List the environmental factors in your terrarium.

How will you provide an optimum range for each factor?

The primary indication of previous learning is the thought the children put into terrarium design; how efficiently they set up their systems is less important.

OPTIONAL ACTIVITIES

Additional experiments. Some of your students may wish to run additional experiments before designing their final terrarium. For example, they may wish to investigate the organisms' responses to other kinds of soil. If the children design additional experiments, help them devise means of collecting data.

Adding other organisms to the terrariums. Some children may wish to add new organisms to their terrariums. Before allowing them to bring these in, you may suggest that the children do some research to determine the optimum environments for particular organisms. The research may entail gathering information from source books as well as experimentally determining organisms' responses to certain factors.

By providing an atmosphere in which a child can bring in new organisms—as long as he or she is willing to find out what they require—you can greatly enhance the value of *Environments,* as well as obtain additional feedback about the unit's impact on your class.

17 The Human Environment

SYNOPSIS

Children discuss and plan a human environment which considers the requirements of all animals and plants.

Suggested time: *One session is sufficient unless the activity develops into a class project.*

TEACHING MATERIALS

For each child:

student manual page 32

TEACHING SUGGESTIONS

The discovery and exploration phase mentioned in Chapter 16 continues.

Begin a discussion of the care and effort the children put into the construction of a proper habitat with all the optimum environmental conditions by commenting, "I wonder if anyone prepares our human environment with as much care as we did the habitat of the organisms in our terrariums." The discussion which follows will vary depending upon the human happiness or suffering in the area of the school. Few human habitats are thought out from the standpoint of providing optimum conditions of environmental factors. The children may be quite vocal, even opinionated when discussing the various environmental conditions in which humans live.

You might intervene at appropriate places during the discussion between the children with some well-placed questions or comments such as: "I wonder if all rats (deer, cows, birds, worms, ants, flies) have perfect environmental conditions available to them, as you think humans should have?" Or, depending upon how the discussion is going: "We take good care of our (rabbit, hamster, gerbil, dog, cat, fish); who's supposed to take care of humans?" Or: "What opportunities do humans have to change their habitat or environmental conditions compared with the opportunities that trees, corn, bushes, snails, or fleas have?"

Encourage the children to recall all the ways in which their homes and appliances have been engineered to improve their environments. Which environmental factors have been controlled for humans? The house protects against wind, heaters prevent temperature drops, air-conditioners prevent temperature increases, humidifiers add moisture to homes in dry areas, dehumidifiers remove moisture from homes in moist areas, fans move air which has been made still by the house walls installed to stop the wind, lights have been installed to compensate for the roof which prevents sun and moonlight from entering, pipes containing water compensate for the unavailability of a stream or lake, etc.

To set the stage for the "What do we need?" activity, remind the students that humans didn't always have grocery, shoe, hardware, and clothing stores, lumberyards, and restaurants. Humans had to hunt for food, search for water, make their own clothes, find or raise their own vegetables and fruits, etc. They didn't live in "beautiful harmony" with other organisms, but they certainly lived with them because they depended on them for survival.

Using student manual page 32. Without suggesting that humans return to the days of hardship, introduce the activity by asking the students to complete this

32 Chapter 17

Make a list of environmental factors humans need to survive.	List the organisms or places from which these factors come.

student manual page. Tell the students to think of how humans probably lived before there were stores, rules, laws, and electricity. What would people have needed to survive, and what environmental factors were probably very important to them? Form groups of four children for this thinking activity, and prepare for a discussion of human dependence upon other organisms by visiting the groups to learn what factors they think are important to human survival. If the children in one group are diverted to considering television or other such unimportant environmental factors, steer them back to more relevant problems. At least a few of your students will have had some camping experience and will be able to recall some of the more important problems that someone had to be concerned about.

What do we need? After the students have completed listing the factors humans need and the sources of those factors, encourage each group to share their suggestions with others. From this sharing, a discussion about the necessity for this or that may ensue.

Using the environmental factors the students thought of, ask each team to separate the biotic and abiotic factors. If you make a column (one for biotic and another for abiotic) on the chalkboard, the students can add the factors as their groups decide. Thus everyone will not have to be at the board at the same time.

After the biotic factor list is completed, look at the human diet that it provides. Do the children think it is adequate? What other kinds of plants and animals are needed for food? Will the abiotic environmental factors they have picked for humans allow those other organisms to survive?

Figure 17-1. Providing for human needs: electricity.

Figure 17-2. Clothing.

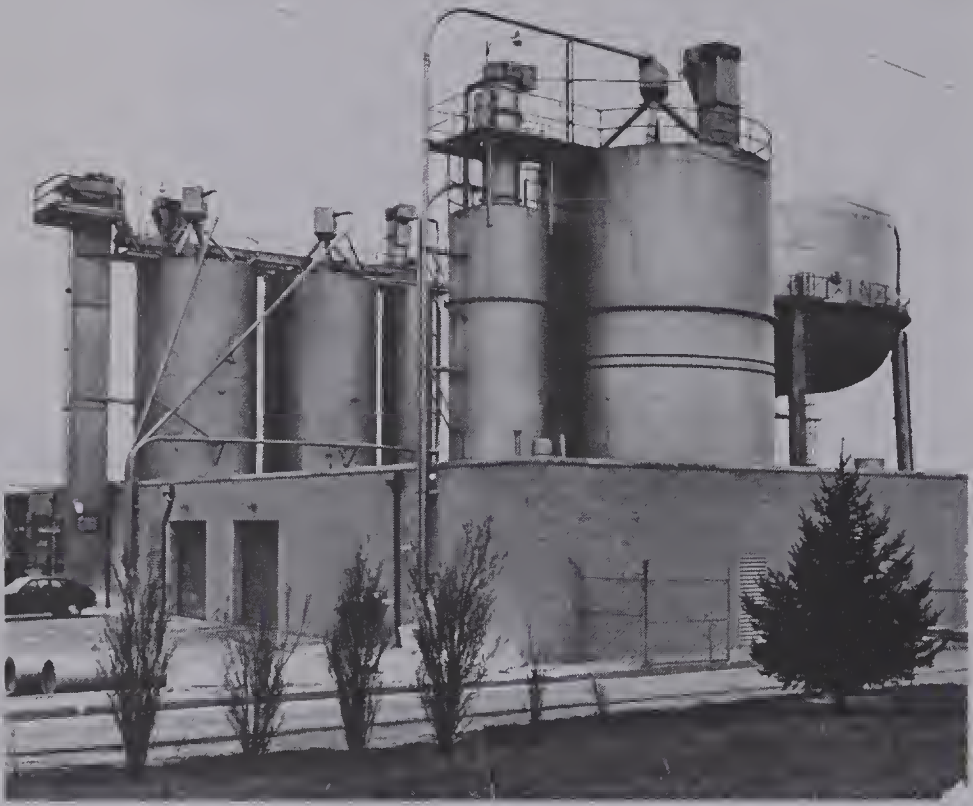


Figure 17-3. Water.

Figure 17-5. Shelter and transportation.

Figure 17-4. Education.

Figure 17-6. Recreation.

OPTIONAL ACTIVITY

Escape from Earth. Have the class or individual children plan an escape expedition for 100 people who are the last remaining humans on Earth after some mysterious disease eliminated all other humans. Where would they go? What other organisms do they need to take with them? What will they grow? What other organisms will they avoid? (Not only those harmful to humans, but those which will eat their crops and food or contaminate their water will have to be avoided.)

Extending Your Experience cards 1–27 are now available for the children's use. For materials needed, refer to the equipment list accompanying the set of cards.

CONCEPT / PROCESS EVALUATION

If you choose to evaluate the children's understanding of abiotic and biotic environmental factors and of variables, turn to page 100 of the evaluation section at the back of the guide.

Appendices

RAND McNALLY

SCIIS

Evaluating Your Students

SCIIS bears upon many aspects of each child's growth and learning, and evaluation may therefore take a variety of forms. We believe the most significant evaluation should occur informally, while the regular classroom activities are going on and you can observe each child's attitudes, skills, and performance, rather than in formal "test" situations. Test scores alone are not appropriate to describe attitudes, and they often are inadequate measures of children's skills or understanding of science concepts. For these reasons we have provided three kinds of evaluation activities:

A. CONCEPT/ PROCESS EVALUATION
- **Activity 1. Environmental Factors**
- **Activity 2. Seasonal Changes**
- **Activity 3. Trees**
- **Activity 4. Interpreting Data**
- **Activity 5. Environments**

B. ATTITUDES IN SCIENCE
- **Curiosity**
- **Inventiveness**
- **Critical Thinking**
- **Persistence**

C. PERCEPTION OF THE CLASSROOM ENVIRONMENT
- **Science Class Report**

An important feature of the evaluation materials is that they can help you identify problem areas and plan more effective teaching of subsequent parts of the unit. In concept/process evaluation, the "Followup" section at the end of each activity provides specific suggestions for remedying weaknesses in student understanding. The materials for assessing children's attitudes and their perception of the classroom environment contain suggestions that can help you improve your teaching effectiveness as well as the attitudes and performance of students. We hope you and your students find these activities both enjoyable and beneficial.

Concept / Process Evaluation

The activities in this section are designed to help you evaluate children's ability to identify and describe the major science concepts and processes of the unit. As explained in the unit "Overview" on page 1, these major concepts and processes are:

environment
environmental factors
range
biotic
abiotic
optimum

In addition, certain secondary concepts and processes are introduced to help the children deal with their observations. These are: adaptation, response, plant growth, experimental control, and variation.

Objectives indicating the concepts and processes emphasized are listed at the beginning of each Part in the Teacher's Guide. Children's understanding and mastery of most concepts and processes can be evaluated informally as the class works through regular activities. It is worthwhile to evaluate children more than once during the unit, because individuals will achieve desired levels of competence at different times.

All of the concept/process evaluation activities can be carried out with individuals or small groups. Thus, you can use an activity to evaluate just the children for whom you are lacking notes or observations. Some activities also lend themselves to use with the whole class; this is indicated where appropriate.

The activities in this section provide you with ways to evaluate children's understanding of major concepts and processes presented in this unit. Some of the activities will also provide information about understanding of concepts and processes that are of secondary importance in this unit or that were introduced in earlier units.

Keeping records. One side of the Class Profile sheet (Evaluation Materials envelope, drawer 1) provides space to record results of each child's work in each activity. In evaluating children's progress we have found it most useful to distinguish three levels of understanding. These levels, and symbols convenient for recording them, are:

○ **Needs special assistance**
✓ **Check again**
● **Satisfactory**

The symbols have the advantage of being changed easily after a child gives evidence of progress. In addition to the symbol, you may add brief comments in the "Notes" column.

EVALUATION
ACTIVITY

1 Environmental Factors

SYNOPSIS

This activity examines the children's ability to identify environmental factors.

Administer: ***to the entire class after Part One***

Suggested time: ***10 minutes***

EVALUATION MATERIALS

For each child:

- 1 copy of Environmental Factors for Plants answer page*

For the group:

Drawer 1

- Environmental Factors for Plants spirit master

* provided by the teacher

ADVANCE PREPARATION

Duplicate the number of answer pages needed for your class.

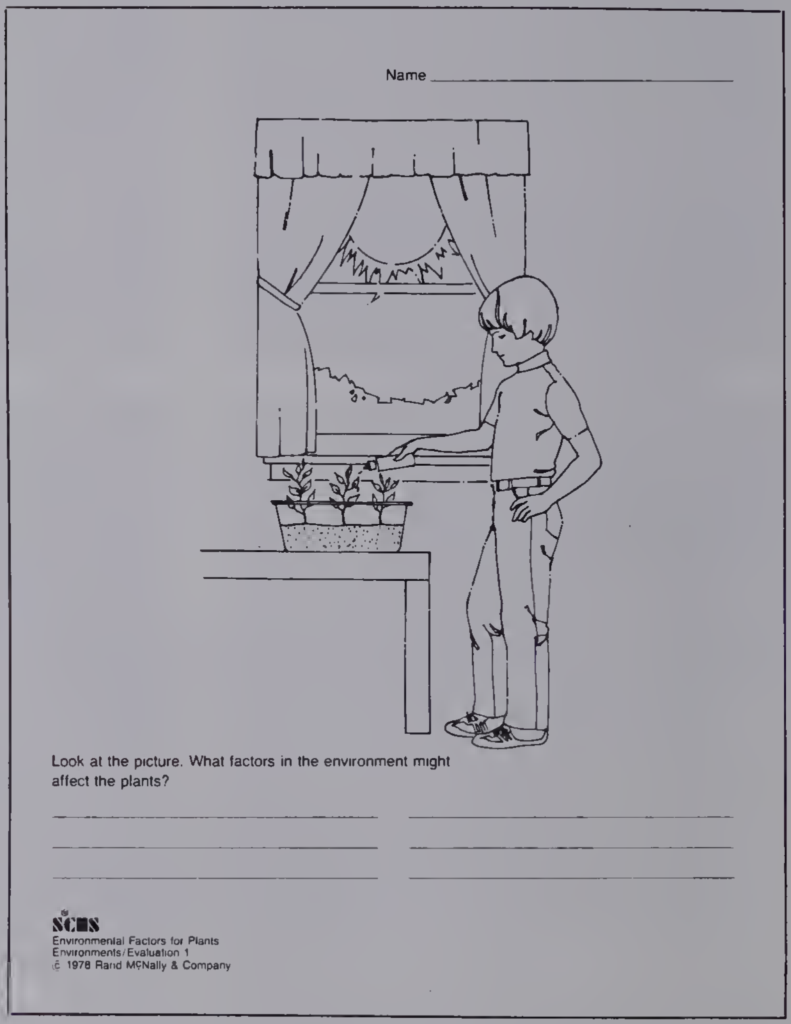
EVALUATION SUGGESTIONS

Distribute the answer pages to the children and read the instructions aloud while they follow along with their answer pages. Tell them that they do not need to write complete sentences. Walk among the students while they are working to provide help with spelling.

Criteria. Water, sunlight, air, and soil are the environmental factors shown in the picture. Children who listed at least three of these give evidence of satisfactory understanding. If, in addition, they added "girl" or "animals," their response is still acceptable. If they included parts of plants (such as stems and leaves) in their list, they need further experience to make the distinction between an organism and its environment. If they included "window" and/or "table," they probably do not discriminate between relevant environmental factors and other objects in the environment. Children who failed to mention any physical factors need special help.

Follow-up. Talk with the children who need help. If they still have the terrariums, let the pupils reexamine these to discover why some failed and others succeeded. Also ask the children to review page 5 in their student manuals. On the basis of these experiences, "reinvent" the concept *environmental factor*. Then ask the pupils to describe the environment of two or three of the organisms that are shown in the Everglades picture.

Figure E-1. The Environmental Factors for Plants spirit master



Name ______________________

Look at the picture. What factors in the environment might affect the plants?

______________________ ______________________

______________________ ______________________

______________________ ______________________

SCIIS
Environmental Factors for Plants
Environments/Evaluation 1
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EVALUATION ACTIVITY

2 Seasonal Changes

SYNOPSIS

This activity measures your pupils' understanding of the correlation between seasonal changes and the changes that occur in plants and animals.

Administer: ***to the entire class after Part Two***

Suggested time: ***10–15 minutes***

EVALUATION MATERIALS

For each child:

1 copy of Seasonal Changes answer page*

For the group:

Drawer 1

Seasonal Changes spirit master

* provided by the teacher

ADVANCE PREPARATION

Duplicate the number of answer pages needed for your class.

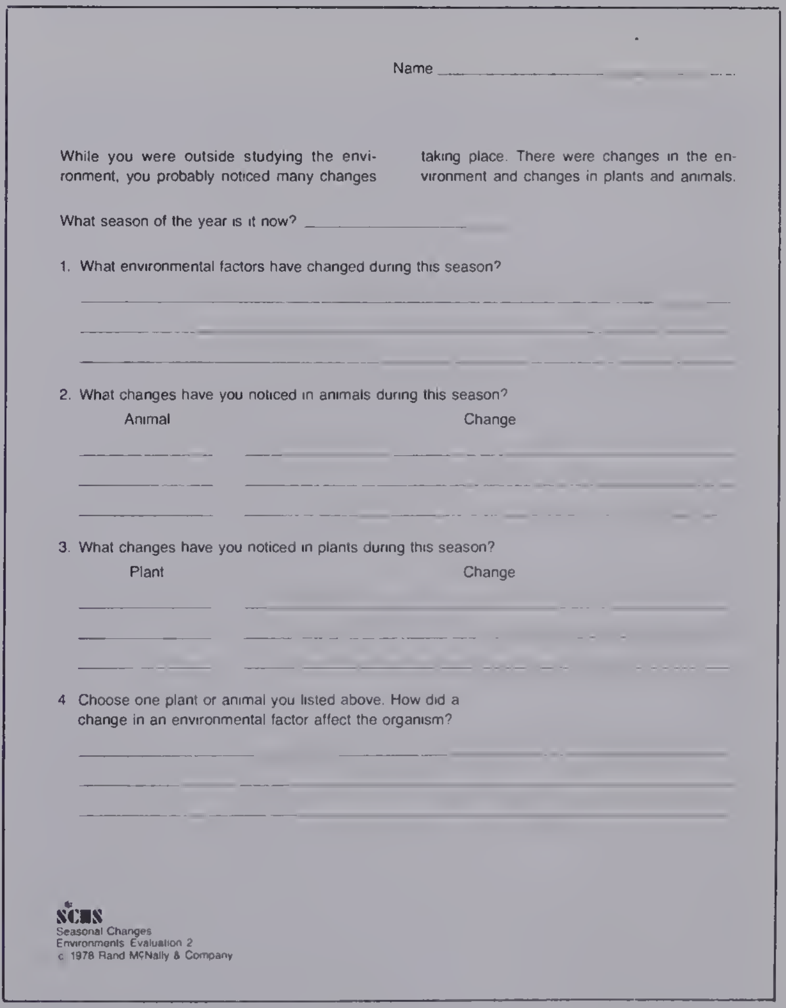
EVALUATION SUGGESTIONS

Distribute the answer pages to the students. Read the text at the top of the page and remind the children of their trips outdoors and the class records of precipitation, temperature, and observations of animals and plants. Read the rest of the page, answer any questions concerning procedure, and let the children complete the activity.

Criteria. The answers to the questions will vary depending on the time of year that you are conducting this activity (flowers blooming and birth of young in spring; leaves falling from trees in fall; migration of birds in either spring or fall). Children who identified two or three environmental factors, named one or two changes that occurred in animals and plants during the season, and described a change in a plant or animal that is correlated with a change in an environmental factor demonstrate a good understanding of the responses of organisms to changes in the environment. Children who provided three or four correct items have a partial understanding, while those who listed fewer than three items need much further experience observing and describing seasonal changes and how these affect organisms.

Follow-up. Talk with the pupils who show a lack of understanding. Discuss the differences in weather conditions from season to season. Review the class *Outdoor Changes* chart. Because temperature changes and changes in plants are the most obvious, concentrate on these and try to elicit some examples from the child's own experiences of the effect of changes in temperature on plant growth, flowering, and so on. Invite students with a poor understanding to tell you about all the changes that take place in northern parts of the country. This can be in the form of a story, recall of something they read, or an actual experience they had. Events such as deer hunting for food, Indians storing food for the winter, turtles hibernating, or birds flying south offer you opportunities to point out change-response relationships that are related to seasonal changes.

Figure E-2. The Seasonal Changes spirit master.



Name ____________________

While you were outside studying the environment, you probably noticed many changes taking place. There were changes in the environment and changes in plants and animals.

What season of the year is it now? ____________

1. What environmental factors have changed during this season?

2. What changes have you noticed in animals during this season?

Animal	Change

3. What changes have you noticed in plants during this season?

Plant	Change

4 Choose one plant or animal you listed above. How did a change in an environmental factor affect the organism?

SCIIS
Seasonal Changes
Environments Evaluation 2
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EVALUATION ACTIVITY

3 Trees

SYNOPSIS

This activity examines the children's ability to interpret data and to relate environmental factors to the growth of trees on a mountain.

Administer: ***to the entire class after Part Three***

Suggested time: ***10 minutes***

EVALUATION MATERIALS

For each child:

1 copy of Trees answer page*

For the group:

Drawer 1

Trees spirit master

* provided by the teacher

ADVANCE PREPARATION

Duplicate the number of answer pages needed for your class.

EVALUATION SUGGESTIONS

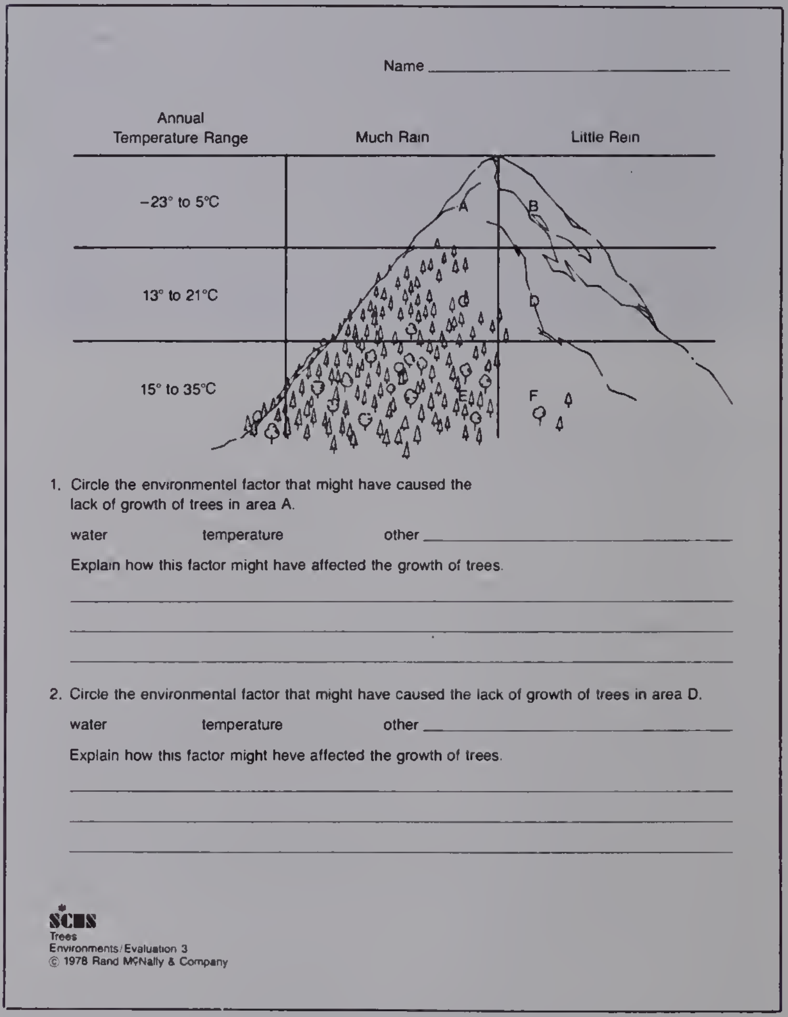
Distribute the answer pages to the students.

Explain that the picture shows a mountain where trees do not grow on one side or at the top (marked *A*). Point out that there is much rain on the left side of the mountain and very little rain on the right side. Tell the class that the temperature ranges shown at the left of the picture apply to both sides of the mountain. Then read the answer page aloud and clarify any questions regarding the picture.

Criteria. (1) The appropriate answer is temperature, because it may be too cold for tree growth at the top of the mountain. (2) The appropriate answer is water, because plants need water and there is very little on that side of the mountain. Children who selected the correct environmental factors and explained them satisfactorily have a good understanding of the relationship between environmental factors and plant growth. Those who wrote in "minerals" and/or "light" and correctly explained their effect on plants also understand the relationship of environmental factors to plant growth. However, they did not use the data shown in the picture. Those students who chose the correct factors but could not explain their choices have a partial understanding. Children who were unable to answer any questions correctly need special help.

Follow-up. Talk individually with children who need help. Ask them to interpret the picture on the answer page to help you discover the basis for their misunderstanding. Ask them where on the mountain there is much rainfall, and where there is only a little. Ask them what part of the mountain is cold and what parts have higher temperatures. If the students can describe the conditions correctly, review with them the class charts showing data on various plant responses to light, temperature, and other factors.

Figure E-3. The Trees spirit master.



Name ____________________

Annual Temperature Range
Much Rain
Little Rein
−23° to 5°C
13° to 21°C
15° to 35°C
A
B
D
E
F

1. Circle the environmentel factor that might have caused the lack of growth of trees in area A.

water temperature other ____________________

Explain how this factor might have affected the growth of trees.

2. Circle the environmental factor that might have caused the lack of growth of trees in area D.

water temperature other ____________________

Explain how this factor might heve affected the growth of trees.

SCIS
Trees
Environments/Evaluation 3
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EVALUATION
ACTIVITY

4 Interpreting Data

SYNOPSIS

This activity investigates the children's ability to interpret and combine data from three experiments, and to use this information in making predictions.

Administer: *to the entire class after Part Four*

Suggested time: *10–15 minutes*

EVALUATION MATERIALS

For each child:

1 copy of Ant Lion answer page*

For the group:

Drawer 1

Ant Lion spirit master

* provided by the teacher

ADVANCE PREPARATION

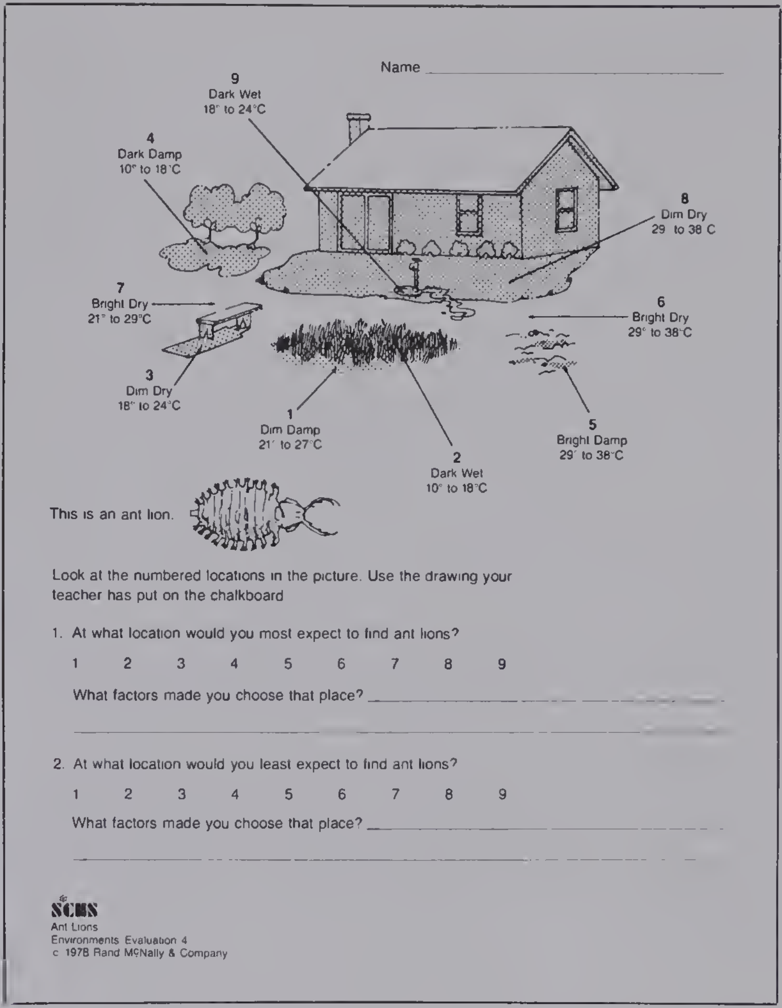
Duplicate the number of answer pages needed for your class.

EVALUATION SUGGESTIONS

Distribute the answer page and point out the picture of the ant lion. Copy Figure E-5 on the chalkboard. Explain that the chart shows the results of experiments in which six ant lions were distributed along the length of a trough similar to the one used in their experiments with isopods. The effect of light on the ant lions was determined in the top trough, the effect of moisture in the middle trough, and the effect of temperature in the bottom trough. The dots mark the spots in the troughs where the ant lions were placed; the *X*'s mark the spots where the ant lions were found fifteen minutes later.

Read the answer page to the class and tell the children to use the data on the board to help them answer the questions. Clarify any questions regarding procedure before the students begin.

Criteria. (1) Location 6, because the degrees of light,



Name ______________________

9
Dark Wet
18° to 24°C

4
Dark Damp
10° to 18°C

8
Dim Dry
29° to 38°C

7
Bright Dry
21° to 29°C

6
Bright Dry
29° to 38°C

3
Dim Dry
18° to 24°C

1
Dim Damp
21° to 27°C

5
Bright Damp
29° to 38°C

2
Dark Wet
10° to 18°C

This is an ant lion.

Look at the numbered locations in the picture. Use the drawing your teacher has put on the chalkboard

1. At what location would you most expect to find ant lions?

1 2 3 4 5 6 7 8 9

What factors made you choose that place? ______________________

____

2. At what location would you least expect to find ant lions?

1 2 3 4 5 6 7 8 9

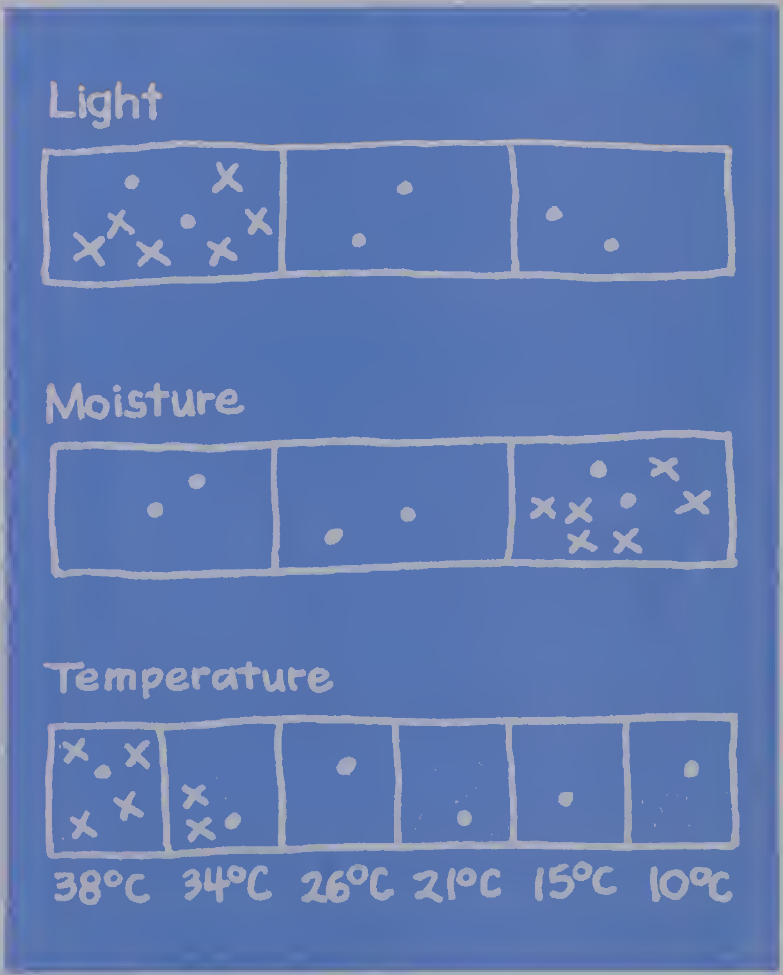
What factors made you choose that place? ______________________

____

SCIIS
Ant Lions
Environments Evaluation 4
c 1978 Rand McNally & Company

Figure E-4. The Ant Lion spirit master.

Figure E-5. Some results of experiments with ant lions.



moisture, and temperature reflect the optimum ranges of these factors for ant lions as determined by the experiments. Students should name the three factors and not simply indicate "that is what the experiment showed." (2) Location 2, because the combination of factors is the opposite extreme of the ant lions' preference as shown by these experiments. Again, students should list specific factors which led them to their answers. Children who gave location 9 or 4 as answers for question 2 are not as familiar with interpreting data as those who answered with location 2.

If the children gave the correct answers for questions 1 and 2, they have demonstrated their ability to interpret data and to use this to make predictions. Those who selected other locations because they considered only one or two of the factors show some ability and could profit from more experience. The children whose selections were apparently random and not based on the data need extensive help.

Follow-up. Talk individually with the children who need help, and ask them to explain what information the chart shows. If they are unable to interpret the data, ask them to redo the experiments on isopods in Chapter 13.

EVALUATION
ACTIVITY

5 Environments

SYNOPSIS

This activity examines the students' understanding of abiotic and biotic environmental factors. It also touches on the variables present in an experimental design.

Administer: ***to the entire class after Part Five***

Suggested time: ***15 minutes***

EVALUATION MATERIALS

For each child:

1 copy of Environmental Factors for Snails answer page*

For the group:

Drawer 1

Environmental Factors for Snails spirit master

* provided by the teacher

ADVANCE PREPARATION

Duplicate the number of answer pages needed for your class.

EVALUATION SUGGESTIONS

Distribute one copy of the picture to each student. Tell the students that this is an illustration of a youngster performing an experiment to find out if snails will go toward water. Tell them that the snails started from the center of the experiment box.

Allow the students as much time as they need to examine and ponder the illustration and then to answer the questions.

Criteria. The appropriate answers to the questions are given below:

1. Light (or darkness); wind (no wind); water; the container; odors.
2. The boy; the boy's breath; the boy's movements; the boy's hand; the other snails.
3. The snails' requirements for light; temperature;

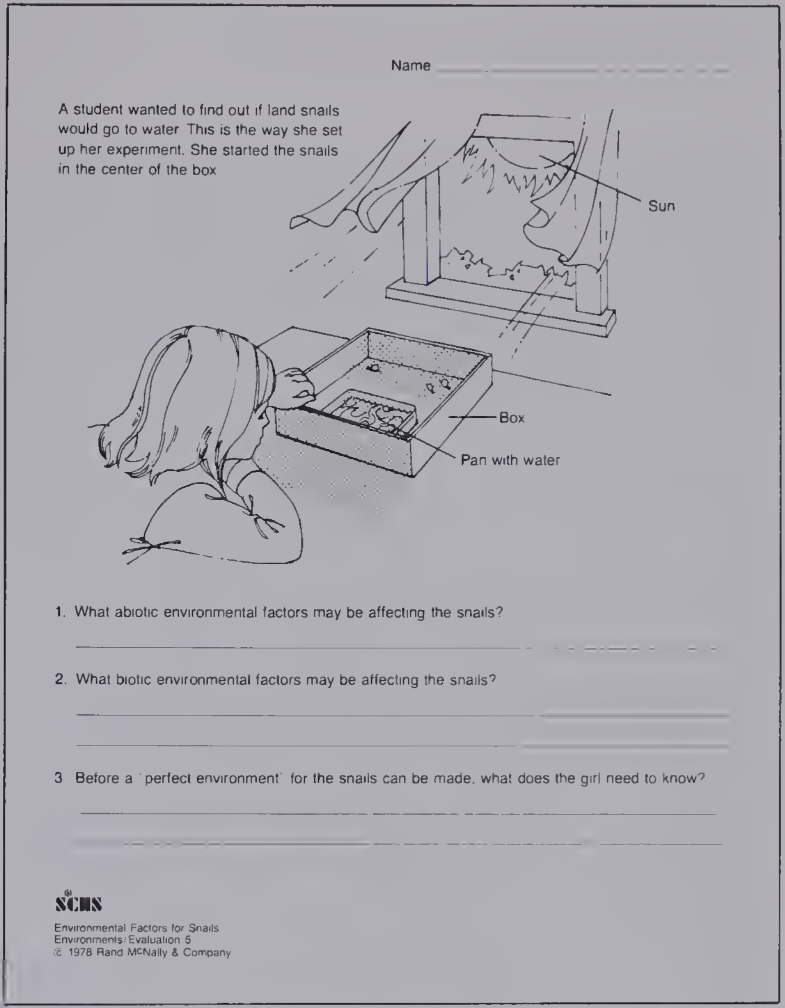
chemicals; food; other animals; water; wind, or no wind; kind of surface (soil, sand, rocks, etc.) preferred or needed.

Students who name at least three different abiotic factors have a good understanding of the concept. Students who name only one factor, or who name two or three factors including a biotic factor, have a limited understanding of the concept.

Students who mention something about the boy or the other snails demonstrate a satisfactory understanding of the *biotic* concept. Those who are unable to list an environmental factor stemming from another organism, however, do not understand the term *biotic environmental factor.*

Students who identify four different environmental factors would probably be able to prepare a proper environment for most animals. Students who have trouble identifying four factors show a limited knowledge of those factors that influence organisms.

Follow-up. Arrange to provide children of limited skills regarding environments with additional opportunities to see how environmental factors affect organisms. Children who sit in bright sunlight squint; those exposed to cold want to warm up before beginning work; cold pets want to come inside; unfed fish in aquariums die; under- or over-watered plants look sickly or die; and so on. There are myriad opportunities to help youngsters realize that humans as well as all other organisms are affected by the environment in general, and are affected by biotic and abiotic factors in particular.



Name ____________

A student wanted to find out if land snails would go to water This is the way she set up her experiment. She started the snails in the center of the box

Sun
Box
Pan with water

1. What abiotic environmental factors may be affecting the snails?

____

2. What biotic environmental factors may be affecting the snails?

____

____

3 Before a 'perfect environment' for the snails can be made, what does the girl need to know?

____

____

SCIIS

Environmental Factors for Snails
Environments/Evaluation 5
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Figure E-6. The Environmental Factors for Snails spirit master.

Attitudes in Science

These comments are designed to help you assess four major attitude areas that can indicate developing scientific literacy in children.

When using this phase of evaluation, keep in mind the question "In what ways is the child behaving like a scientifically literate individual?" During your day-to-day science teaching, look for evidence of positive attitudes in the following areas:

Curiosity. Children who pay particular attention to an object or event and spontaneously wish to learn more about it are being curious. They may give evidence of curiosity by—

- using several senses to observe organisms and other objects
- asking questions about objects and events
- eagerly examining organisms, equipment, or other materials at the time they are first distributed
- showing interest in the outcomes of experiments

Inventiveness. Children who generate new ideas are being inventive. These children exhibit original thinking in the interpretation phase of an activity. They may give evidence of inventiveness through actions or verbal statements by—

- using equipment in unusual and constructive ways
- suggesting new experiments
- describing novel conclusions from their observations

Critical thinking. Children who base suggestions and conclusions on evidence are thinking critically. They may exhibit critical thinking largely through verbal statements by—

- using evidence to justify their conclusions
- pointing out contradictions in statements by others
- changing their ideas in response to evidence

Persistence. Children who maintain an active interest in a problem or event for an extended period of time are being persistent. They are not easily distracted from the subject at hand. They may give evidence of persistence by—

- continuing to investigate materials after the novelty has worn off
- completing an activity even though their classmates have finished earlier
- redoing an experiment while making some manipulative or procedural changes to improve the results

Of course, the behaviors related to these areas are not restricted to science; they may be observed in other curriculum areas when suitable opportunities exist.

Observing a whole class busily engaged in diverse activities makes attitude-evaluation of individuals virtually impossible for one teacher. We recommend that you focus your attention on attitudes demonstrated by four or five children during each session. You may do this by following an alphabetical class list or by concentrating on one or two teams per session. If you learn something about four or five children during any one session, then you will be able to make a note about each child four or five times in the teaching of one SCIIS unit. Active, vocal children will gain your attention more frequently; quiet children may escape your notice for some time. Adopting a plan for observing class members ensures that you will not overlook any individuals.

In addition to observing the children, an effective way to measure attitudes is to ask divergent questions about the work they are doing. By listening carefully to their responses, you will obtain significant feedback regarding their attitudes.

Keeping records. Space is provided on the Class Profile sheet (Evaluation Materials envelope, drawer 1) for recording observations about each student's attitudes four times during the unit. In the "Notes" column, you may include a short statement indicating what you observed each time the child was selected. Many teachers make their notes while the children are cleaning up at the end of the activity.

The use of this informal but organized assessment system will provide you with a great deal of information about the children's development and will assist you in planning for effective instruction in science.

Perception of the Classroom Environment

This activity indicates how the children assess the nature of the classroom during science — or how they would like it to be. The activity answers the following questions:

- What do the children think about major topics studied in this Part of the unit?
- Do the children see science class time being used in the way you intend it to be used? Do they feel that they are active participants?
- Which kinds of science activity — experimenting, writing or drawing, listening to the teacher, discussing, or reading — do they generally prefer?

Children are sensitive to suggestions from adults. To avoid unduly influencing pupils' perceptions of the classroom, you must be completely noncommittal about what you think is most important or most interesting.

In our experience, most children prefer experimenting, but some do prefer to read or listen to the teacher. Certainly all five kinds of activity are important in a balanced science program, and they should be combined in a way that benefits children most. In field tests of these materials, teachers reported that they could anticipate many children's responses, but that there were usually a few whose perceptions or preferences surprised them and helped them to adjust their teaching accordingly.

The following activity has been written in a style similar to that of the regular SCIIS activities in the hope that the children will see it as a natural part of the learning sequence rather than as a formal examination. The activity may be used at the end of each Part in the unit.

Science Class Report

SYNOPSIS

Children use a report form to indicate (1) their opinions about topics investigated in the Part just completed; (2) how they think their science class time was used; and (3) which kinds of science activity they liked best.

Administer: ***to entire class at conclusion of each Part***
Suggested time: ***five to ten minutes***

EVALUATION MATERIALS

For each child:

1 Science Class report page*

For the class:

Drawer 1

Science Class report form
spirit master (Evaluation Materials envelope)

* provided by the teacher

ADVANCE PREPARATION

Duplicate the required number of the Science Class Report pages. (If you are using this activity for the first time, you will probably want to make enough copies to use the activity at the end of each Part in this unit.)

For question 1, list on the chalkboard the major topics or activities investigated in the Part just completed.

Your list could include some of the following:

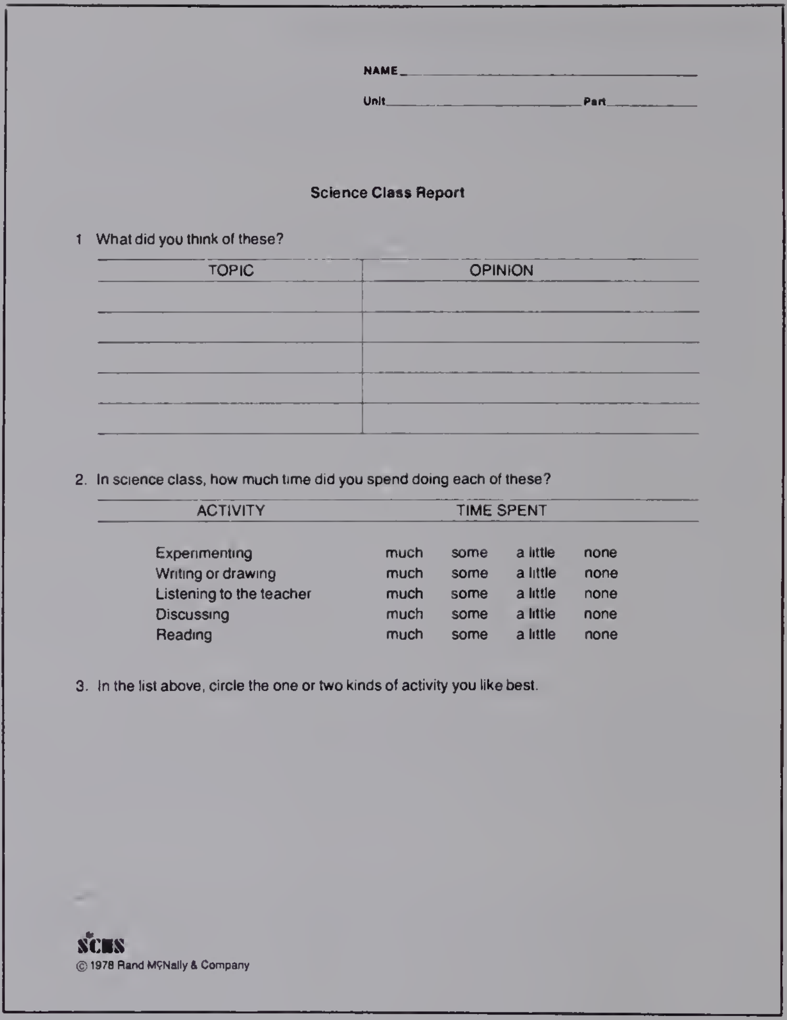
Part	TOPIC
1	measuring precipitation
2	winter and spring environments
3	variation
4	hermit crabs
5	human environments

EVALUATION SUGGESTIONS

Distribute copies of the Science Class Report page. The first time you use this activity, explain the procedure to the class. For question 1, have the children copy your list of major topics from the chalkboard. Ask them to rate the topics by writing their opinions on the lines provided — either in words (interesting, boring, difficult, easy, seemed long, seemed short, etc.) or by means of letter grades. For question 2, ask the children to circle the word that best describes the amount of time they think was spent on each kind of activity during the Part. For question 3, ask them to circle one or two of the words or phrases in question 2 that describe the kinds of activity they prefer.

Collect the papers and review the responses. Look for topics that aroused a great deal of interest, and follow these up with additional optional activities from the appropriate chapters. Look for "weak" spots — topics or activities that were not well liked by a large number of pupils. Try to identify the reasons for such negative opinions. Discuss these reasons with the class, and invite the children to suggest ways of modifying the treatment of the topic that would make it more interesting.

As you review responses to questions 2 and 3, keep in mind that a balanced program includes all the kinds of activities listed; but in an investigative program such as SCIIS, experimenting usually should be most prominent, and reading and listening to the teacher usually least prominent. If the children perceived a different emphasis than you intended, review "Helping Children Learn with SCIIS" (page xvi) and the "Teaching Suggestions" in the next few chapters, to help you plan future science periods.



NAME____________________

Unit________________ Part________

Science Class Report

1 What did you think of these?

TOPIC	OPINION

2. In science class, how much time did you spend doing each of these?

ACTIVITY	TIME SPENT			
Experimenting	much	some	a little	none
Writing or drawing	much	some	a little	none
Listening to the teacher	much	some	a little	none
Discussing	much	some	a little	none
Reading	much	some	a little	none

3. In the list above, circle the one or two kinds of activity you like best.

SCIIS

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Glossary

The definitions in this glossary are intended for your use and quick reference. We do not recommend that you use them verbatim to answer children's questions.

abiotic – not from or of an organism.

adaptation – a modification in a plant or animal that enables it to function in a particular kind of environment.

animal-eater – an animal that uses other animals as a food source; usually a predator.

biotic – from or of an organism.

community – a group of plants and animals that live in the same area and are dependent on one another for food and other requirements.

consumers – the group of animals in a community that eats plants or other animals. The consumers make up one of the functional groups in the community. The other functional groups are producers and decomposers.

controlled experiment – an experiment consisting of at least two setups alike in all ways but one — the variable whose effect is being investigated.

decay – the breakdown of organic material due to the digestive action of microorganisms such as molds, bacteria, and yeasts.

decomposers – the group of organisms in a community (usually bacteria, molds, and yeasts) that causes decomposition (decay) of organic matter. Other groups are producers and consumers.

ecosystem – a unit consisting of a community interacting with its physical environment.

environment – the combination of all external factors that affect and influence the growth, development, and reproduction of organisms.

environmental factor – any part of the environment (such as chemicals, water, or light) that affects organisms and to which they respond.

fertilizer – an artificial or natural source of minerals used by plants.

food chain – a concept that can be diagramed to depict the food relations among plants, plant-eaters, and animal-eaters. For example:
wheat → crickets → frogs → raccoons.
A food chain may consist of only a plant and an animal population that eats it. For example:
corn → humans.

food web – two or more interconnected food chains.

germinate – to begin to grow; to sprout.

habitat – the place in the environment where a particular organism normally lives.

humidity – moisture or dampness in the air.

larva – the first state after hatching of an animal that undergoes metamorphosis.

life cycle – the sequence of changes as an organism develops from an egg to an adult, which in turn produces eggs or sperm that give rise to the next generation.

metamorphosis – in animals having decidedly different life cycle stages, the change from one to the next.

molting – the shedding of skin, feathers, or hair by animals.

optimum – that part of a range of an environmental factor in which an organism lives best. (See *range*.)

organism – an individual living thing; any plant or animal.

plant-eater – an animal that uses plants as a source of food.

population – a group of organisms of the same kind living and reproducing in a particular area. Population size is determined by the number of individuals in the group and not by the physical size of the individuals.

precipitation – rain, snow, or other forms of condensation in the natural water cycle.

producers – the green plants in a community. They produce the food that supports all the organisms that live in the community.

pupa – the transition stage of insect metamorphosis, between larva and adult, of many insects that undergo metamorphosis. The animals in cocoons and chrysalids are pupae.

range – all the intensities of an environmental factor between a minimum and a maximum. A range in the amount of water may be from dry to soaked. (See *optimum*.)

response – here, an organism's reaction to an environmental change.

terrarium – a container of soil in which land organisms can live.

variation – difference in appearance and response among organisms of the same kind (species) or among different species.

SCIIS Plants and Animals

The organisms used in the SCIIS life science units have been chosen for their resiliency and ease of maintenance as well as their behavior, feeding relationships, and life cycles; no complicated feeding or housing arrangements are required. Nevertheless, some preparations for the arrival of organisms are necessary. Aquatic organisms, for instance, need aged tap water, in which the chlorine content is reduced below the level that is harmful to the organisms. Terrestrial organisms need a container with plants or animals that serve as food. On the following pages you are given both background and maintenance information on the plants and animals studied in this unit, as well as general information on planning and ordering procedures.

PLANNING THE UNIT SCHEDULE

Living organisms are the focus of the children's investigations in the SCIIS life science units. Ordering and maintaining the organisms during the teaching program are therefore important responsibilities for you and your pupils.

In planning to teach a life science unit, first examine the "Schedule of Activities" on the last page of this guide. The schedule identifies the activities in the unit and indicates the approximate time required for each one. Also indicated are the times when organisms should be ordered. Use the schedule along with the following instructions to make sure that you receive living organisms when you need them.

ORDERING LIVE ORGANISMS

The seeds and live organisms for SCIIS are to be obtained through Rand McNally & Co. In each kit you will find an envelope containing one or more forms to be used in ordering the organism shipments.

What to order. The contents of the Environments Shipment are as follows—

EN-1: Isopods, beetles, land hermit crabs.

When to order. As you proceed through the Teacher's Guide, watch the "Getting Ready" notices—you will be reminded to send in the order form well in advance of the time when you will need the shipment. It is very important to you and the children that the organisms arrive on time: *You must make sure that the order is mailed three weeks before the shipment is needed.* This is because the supplier not only must process the order, package the shipment, and allow time for shipping, but in some cases must make other preparations. Also, the organisms must be carefully selected so that they will be the correct age and size and in proper condition for use in the classroom.

How to order. Complete the order form for the shipment, including the date when needed, your name, and the school's exact address. Do *not* have these shipments sent to your district's central supply department or warehouse! The arriving organisms will need your care immediately and must not sit on a shelf. To prevent your shipment from being treated casually when it arrives at your school, foreware the mail or package sorter of its impending arrival and firmly request that you be notified as soon as it is received. Too many organisms have died in their shipping containers after languishing for a week only a few doors away from the waiting children.

Preparing for arrival. The preparations necessary for SCIIS organisms are minimal, but they are important. The sooner you can get the organisms out of their shipping containers and into their proper habitats, the better for the organisms.

Before any organisms arrive, tell the children that in handling the plants and animals, they should be as careful as they would be with their own pets. No SCIIS organisms will hurt them, but the children should keep their hands away from their faces while working with the organisms and wash their hands afterward.

Water. *Environments* deals only with terrestrial organisms, and only tap water is needed for them. The directions that follow are for your use in case you decide to provide additional experiences with aquatic plants and animals.

Water to be used in aquariums can usually be taken from the tap, but you should not put organisms into tap water immediately. "Age" it by leaving it uncovered for at least two days to allow the chlorine to escape. If you age water in 1-gallon jugs with small necks, be careful not to fill the jugs completely, or the water's top surface area will be too small for rapid exchange of gases.

Another source of water is spring water from a grocery store or a bottled water company. Do not confuse spring water with distilled water—they are different! We do not advise using distilled water, because it is not supposed to contain any chemicals other than pure water. All animals need certain elements that are always present in spring, pond, or tap water.

Sand and soil. These items are provided with the equipment kit and have been carefully chosen for suitability wih the organisms and equipment in the program. Sand to be used in an aquarium must be rinsed of dust so the aquarium water will remain clear: half-fill an aquarium with sand, add water while stirring the sand, and pour off the cloudy water. Continue flushing the sand with water and discarding cloudy water until the water remains clear after the sand has settled. Distribute the washed sand to other aquariums.

The soil has been pre-mixed in the proper proportions for good growth and drainage, and it needs no further preparation.

Plants. In some units, including *Environments,* arriving terrarium animals should have growing plants waiting for them. Be sure to plant seeds at least a week before adding animals to the terrariums.

CARE OF PLANTS IN THE CLASSROOM

A classroom isn't always the best environment for plants. Your room may be very dry, cold, hot, bright or any combination of factors. But by concentrating on the three environmental factors over which you can have some control—water, light, and temperature—you will have success with the plants we have selected.

Before beginning the unit, decide where you will grow the plants, keeping in mind the amount of light, temperature, and drafts. Also consider whether the plants will be bumped into often, and if the children will be able to observe them easily. Using the following list will help you find the best place for your plants and to give them good care.

Water.

- The amount of water is the *most* important environmental factor for plant development and growth. While classroom temperature and light variations can speed up or slow development and growth, excessive water variations quickly *kill* plants. A fast- or slow-developing plant is infinitely better than a dead one!
- Use enough water to darken the soil. The soil is too wet if (1) you can squeeze water from a large pinch of soil, (2) you can see water in the planter base, or (3) a seed rots.
- The soil may be too dry if (1) a pinch of soil crumbles, (2) the seeds in it don't sprout, or (3) the seeds in it sprout later than the seeds planted in wetter soil.
- We can give no prescription for how much water should be given, or how often. Each classroom is different, and you must watch your plants' soil.
- The heat and low humidity in some classrooms cause plants and soil to dry out very rapidly. In such rooms avoid placing the plants in any drafts.
- For vacation periods place all the plants together, water liberally, cover with a large plastic sheet (a drop cloth or dry cleaners' bag), and leave a light on to help maintain the temperature about 10°C (50°F). Tell the custodian not to turn off the light.

Light.

- Light is not needed until plant parts emerge from the soil.
- After emergence, the equivalent of a 100-watt bulb about 80 cm from the plant is sufficient for good growth.
- Whether the light is from sunlight or from an artificial light source, the plants in this unit will grow. Natural light is better than artificial unless you have so much sunlight that the soil and plants dry out or become too warm. A table or shelf near the windows, but not in the draft of the heater or air-conditioning fan, is a fine place for storing plants.
- Windowsills are often problem spots. Depending on the time of year, they may be too hot, too cold, or too windy; or the shades and curtains may knock over the plants.

Temperature.

- 15–35°C (59–95°F) is the acceptable range. However, 20–25°C (68–77°F) is best.
- If you use an artificial light source, remember that whenever the plant is receiving light it is also absorbing heat from the bulb, and the plant may be much hotter than the room. Adjust the lamp height as necessary.
- The heat from any source of light may cause the soil to dry out, which is critical. Water is more important to plants than light or temperature.

Possible plant problems. In spite of your conscientious care, you may have trouble with seeds or plants. If you do, use the "Checklist of Plant Problems" on the following page.

CARE OF ANIMALS IN THE CLASSROOM

All the animals selected for use in this program will live in your classroom. However, we often find variations among classrooms that can cause some problems. Your room may be too dry, cold, bright, or hot for some of the animals. In many schools the heat is turned down at night and on weekends; some schools are dark; in others the blinds must be pulled down every afternoon; and some are in areas of very low or high humidity. Some rooms with a southern exposure heat up. Rooms with windows on the west side may have bright sunlight at four or five o'clock, after everyone has gone home—everyone but the SCIIS organisms, which then find themselves literally in hot water. The next morning the water has cooled and everything looks normal, but many organisms are dead.

To prevent such disasters and the resulting disappointments for the children, set aside ten minutes to read the section beginning on page 111, describing the key points in maintaining each of the animals. Environmental factors which can severely affect classroom animals are water, light, temperature, and food.

Water.

- The isopods need a moist environment such as that provided in the terrariums. However, if water is standing in the terrariums, the isopods can drown.
- Mealworm beetles should be given pieces of potato or apple for moisture. Replenish when the potato or apple has become dry or every four days, whichever happens first.
- Provide a small dish of water for the hermit crabs and see that it is kept filled.

A CHECKLIST OF PLANT PROBLEMS

Failure of seeds to develop.

___ Too much water causes rot. Dig up one seed. If it is rotten discard the seeds, let the soil dry out, and start over.
___ If too little water has been added, the seeds will be unchanged from when they were planted. Water the soil thoroughly after replacing the seeds, and be sure they are not receiving too much heat.
___ You may not have waited long enough. Some seeds are slower to develop than others, though the kinds of seeds provided in the kits should sprout within nine days. Seeds will develop slowly if they are cold or haven't received enough water.
___ The seeds may have been planted too deeply, or the soil may have been pounded down on top of them. If you think this is the problem, dig the seeds up and plant them again.
___ In any group of seeds, a few will fail to develop. Assume 9 out of 10 seeds planted will develop, and be sure the children plant enough seeds to allow for this.

Animals on the plants or soil.

___ This usually occurs in overwatered plants. Reduce the amount of water given, and be sure none is standing in the planter bases.
___ Animals are free sources of live organisms—use them. They probably will show different life cycle forms. Aphids and gnats are common and will reproduce on plants and soil.

Blemishes.

___ Symptoms such as discolorations, leaf curl, and fuzzy spots on soil or plants are probably caused by molds or other fungi. Dry the plants out by watering them less and increasing the amounts of light and heat they receive.
___ Blemished plants will not necessarily die. To prevent infection of healthy plants, isolate the infected plants until they recover.

Breakage.

___ Protect plants from breaking by storing them where the children are not likely to knock them over or brush against them.
___ Allow only a few children to retrieve their plants at a time. This reduces jostling that might otherwise occur.
___ Encourage children to be gentle with the plants as they work with them.
___ Avoid storing plants near windy doorways or windows, where they might be blown over.
___ Use support sticks and ties for tall plants grown in pots.

Miscellaneous problems.

___ Sick-looking or dead plants may have lost too much water over the weekend. The solution is to water plants more on Fridays, or to cover them with waterproof plastic wrap, being careful the plastic does not break them.
___ Diseases are possible, but unlikely. Discard any diseased plants and plant new seeds.
___ Weak stems are usually caused by an overabundance of water, by the addition of more soil after the plant has sprouted, or by insufficient light. Have the children use less water, support the plants with sticks and ties, and be especially careful with these plants.
___ Kinked stems can be salvaged if they are kept straight with splints. Use yarn, tape, or a twistem to attach a stick or pencil to the weakened section of the stem.

Light and temperature.

- The presence or absence of light alone will not harm your animals. However, light also gives off heat that builds up inside containers.
- Check the temperature with the back of your hand.
- For each animal there is an optimum temperature, but none of the animals supplied will be harmed if you keep the temperature between 10°C (50°F) and 25°C (80°F).
- Temperatures below 23°C (75°F) will tend to slow the rate of development a little. But as with plants, an organism that develops too slowly is far better for your purposes than a dead one.
- When in doubt about whether to raise the temperature another degree or two, ask yourself whether there is danger of raising it too much if you forget to monitor the increase. If so, do not try to raise the temperature. Remember, this unit *cannot* be taught without live organisms.

Food. You really can't overfeed the animals in this unit, but you can provide so much food that it is left to spoil.

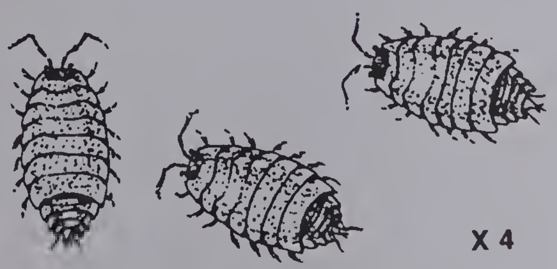
- Isopods are scavengers and will feed on plant material in the terrarium soil.
- If the beetle food becomes moist, it will spoil and harm the animals. Exchange any moist food for dry.
- Hermit crabs need very little food. Give them small pieces of apple or dry pet foods.

PLANT AND ANIMAL SHIPMENTS FOR *ENVIRONMENTS*

Isopods.

Receiving the organisms. The isopods ('ī-sə-'padz) should be distributed within one day after they arrive. Check to see that most of them are alive. If they are not, report it to the supplier immediately so that a new shipment can be sent.

Figure L-1. Isopods.



If you need to keep these animals in the shipping container for another day, be sure that the shipping soil is moist to the touch, and that you do not allow the isopods to dry out before distributing them. These animals breathe by means of gills, which must be moist at all times.

Classroom care and maintenance. Isopods need little care, but moisture must be present at all times. If the surface soil dries out, isopods will usually be able to "follow the moisture" by burrowing deeper into the soil.

The SCIIS soil has sufficient organic matter in it to supply all the food the isopods need, so there is no need to feed them.

As with all SCIIS organisms, distribute isopods to the children as soon as possible. The environment provided by the children's terrariums is far superior to that of the shipping container.

Description and natural history. Like their relatives—crabs, shrimps, and lobsters—most isopods are aquatic. Certain species, however, such as sow bugs, pill bugs, and wood lice, live on land. These are found in most parts of the United States. One interesting feature about the isopods used in this unit is that they are among the few terrestrial animals using gills for respiration. It is for this reason that isopods must be kept in an environment that is moist at all times. However, isopods can "drown" when their environment is too wet.

Isopods eat anything soft and moist and thus are effective scavengers. Because they are able to digest and utilize the cellulose in wood and leaves, they are often found in forest debris.

Female isopods bear as many as 200 young after mating. The female carries fertilized eggs in a brood pouch on the underside near her posterior end. The young emerge from the brood pouch a few days after hatching and look like tiny, pale replicas of adult isopods.

Disposal. Like other organisms, isopods can be frozen and discarded in plastic bags.

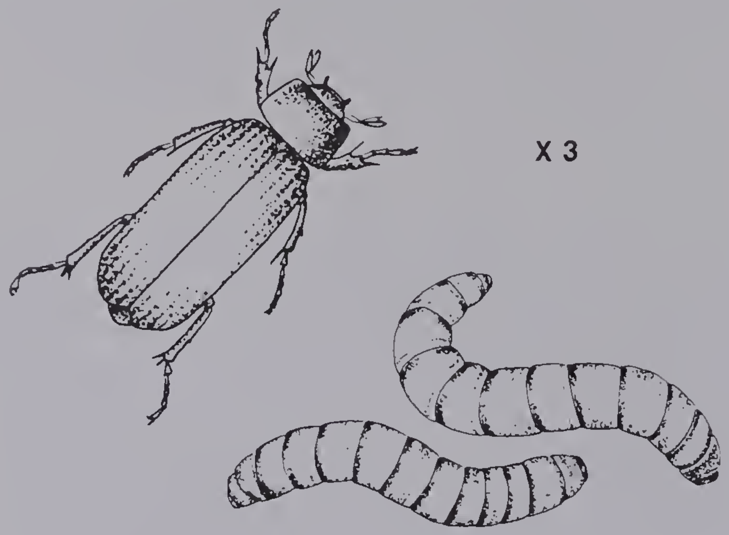
Mealworms.

Receiving the organisms. Open the beetle shipping container and look for the black or brown beetles. They are usually quite active, but you may have to prod some with a pencil to see if they are alive. (If the container is cold, the beetles will be quite slow and will not move even when prodded, although they probably will move their heads or antennae. Put the container in a warm place and check later to see if most of them are alive.)

You should receive at least 75 beetles. If you do not have at least 65 healthy beetles, contact the shipper and request more.

Place the shipping container and beetles in a dark closet after removing the top of the container to allow

Figure L-2. Mealworm larvae and adult beetle.



exchange of air. The beetles will not crawl out.

The shipment arrived with a piece of vegetable to supply moisture to the beetles. Every three days, check to see if the vegetable needs replacing. Potatoes, celery, apples, carrots, and other firm and bulky vegetables will supply moisture without drying out rapidly; thin vegetables such as lettuce tend to dry too quickly.

Classroom care and maintenance. After the beetles have been used for the children's experiments, they should be placed in the terrariums, where they will need little care. Fallen leaves or broken stems, along with the humus in the soil, will provide plenty of food.

Children have a tendency to water their terrariums too frequently. This excessive moisture can harm the mealworm beetles.

Description and natural history. Mealworms are beetles that derive their name from their wormlike appearance in the larval stage. The adult has the wings and chewing mouthparts characteristic of all beetles. Mealworms are scavengers that are found in stored grain. They eat grain, rotting plants, dead insects, and occasionally each other.

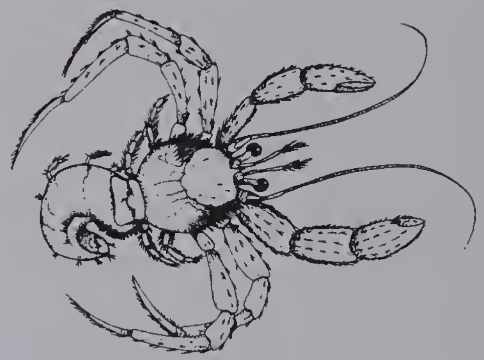
The mealworm life cycle is interesting because, like many other insects, the developing larva metamorphoses (changes form) as it becomes an adult. The mealworm larva molts (sheds its skin) several times as it grows. In a month or so, the active larva becomes an inactive pupa; the length of the larval period varies depending on food, moisture, and temperature. The pupa stage lasts from one to three weeks, during which time the change to adult beetle takes place. Adult males and females mate soon after emerging from their pupal cases. The females lay eggs that hatch into larvae, and new individuals begin their life cycle.

Disposal. Mealworm beetles may be used as food for turtles, frogs, toads, lizards, or small snakes. If no predators are available, put the beetles in a plastic bag and freeze the bag.

Land hermit crabs.

Receiving the organisms. You will receive 18 hermit crabs. The crabs will arrive in a ventilated container containing some material on which the crabs can crawl and support themselves.

Figure L-3. Land hermit crab.



Remove the crabs from the shipping container and distribute them to the children—two for each terrarium, with any extra crabs distributed as equitably as possible. Only 16 crabs are needed for a class of 32, but two additional crabs have been provided to ensure that you will have enough for the entire class.

If the crabs arrive during a class period, tell the children what they are. Explain that the crabs must not be allowed to fall and crack their shells, and let the children explore these new animals (preferably on the floor). These crabs and their pincers are small; there is little danger of a crab pinching a youngster, but under the right circumstances (such as a very small fold of skin exposed to an alarmed crab) it may happen. This happened only twice during our trials and resulted only in startled children. You may wish to tell the children that a crab's largest pincer can pinch when the crab is trying to hang onto a precarious perch or if it is startled while climbing.

Classroom care and maintenance. Hermit crabs are excellent climbers, and so they may escape if you place sticks in the terrariums with them. Always keep the terrarium lid in place if there is anything in the terrarium the crabs could climb up on and escape.

Provide the crabs with water by half-filling a planter cup base or similar container and placing it on the soil in each terrarium. Change the water as often as needed.

Description and natural history. These crabs belong to the genus *Coenobita* and the species *clypeatus*. They come from the Caribbean islands and the Florida Keys. These crabs are not really "hermits" in the sense that they live alone. A hermit crab takes the abandoned shell of another animal as its own for use as long as it fits. This is probably the reason for their being called "hermits."

Land hermit crabs are also known as tree crabs because they are often found in trees. They are excellent climbers and can get over any rough obstacles.

These omnivorous animals can survive on very little food and water. They eat a variety of foods, including apples, dry pet foods, and leafy vegetables. They eat so little that it is difficult to tell by the remaining food just how much was eaten the night before.

Disposal. These animals are not pests, and so it would not be harmful to the environment if they were released. However, in all but the warmest parts of the United States, they would probably die when winter arrived. Keep the crabs as pets, give them to other teachers, or return them to your school's living materials center. If none of these procedures is possible place the animals in a container, freeze them, and then discard them.

Design and Use of the Kit

The equipment kit has been designed to help you teach the unit effectively. Except as noted below, all materials needed for a class of thirty-two students have been included. The items are packaged for convenient removal, use, and reuse. In response to feedback from users of SCIS, we have placed a contents list on the front of each drawer. In addition, the chapter "Teaching Materials" lists are now arranged by drawer number.

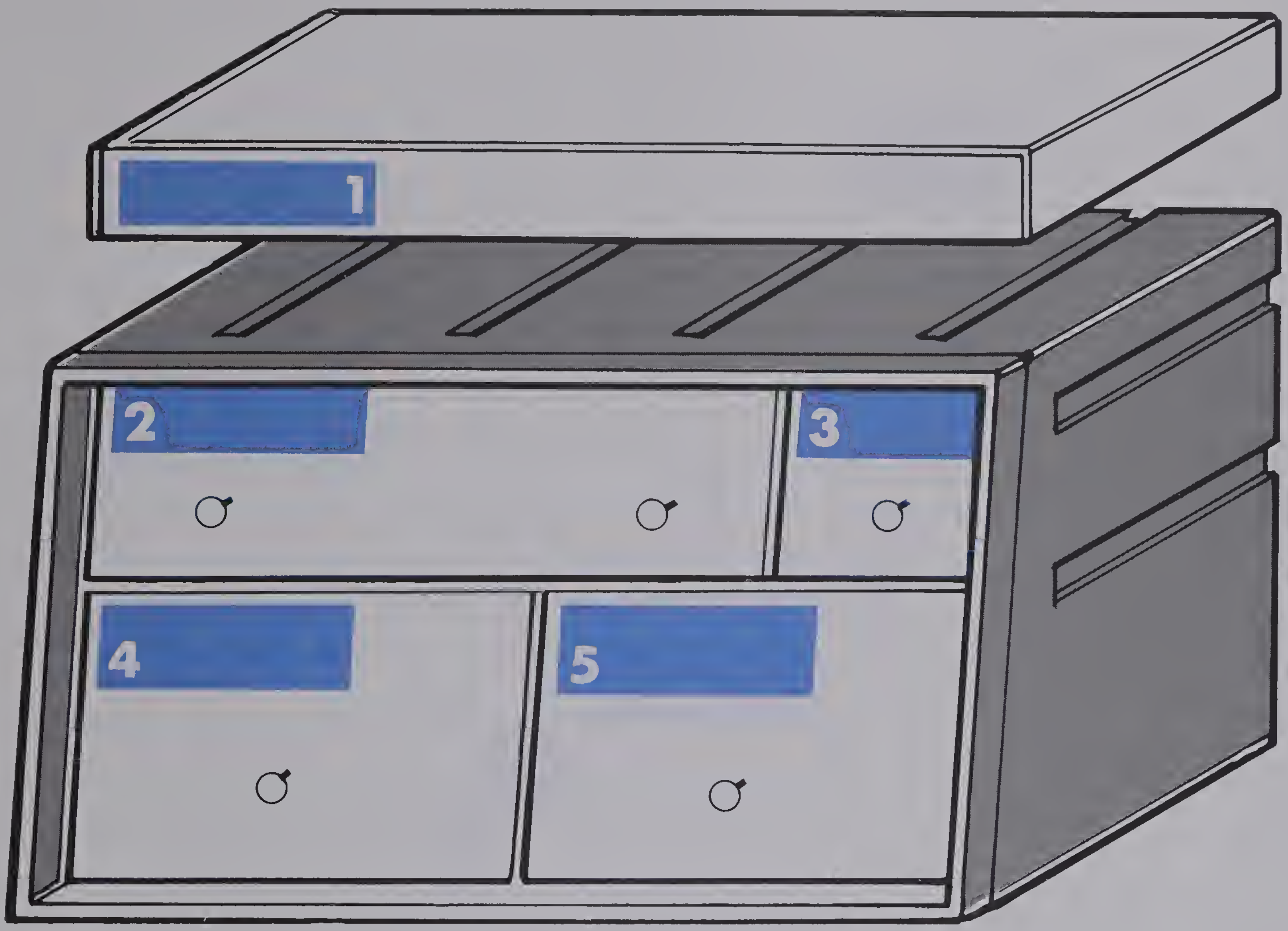
Familiarize yourself with the entire kit as well as with the diagram and lists on this page. You should inventory the kit before beginning to teach the unit, using the lists on this page for checkoff and notes.

Drawer 1, containing the printed materials, is a separate box. Place it on top of the kit as indicated in the diagram.

Some common items are to be provided by the teacher. The "Teaching Materials" list for each chapter indicates what you are to provide, and the "Getting Ready" notices give you advance warning about these items when necessary.

The live organisms studied in this unit are not included in the kit. Instead, they will be sent separately when your completed order forms are received. Complete directions for ordering are in the "SCIIS Plants and Animals" section.

Drawer	Item Description and Quantity
1	1 Teacher's Guide
	32 student manuals
	2 sets of Extending Your Experience cards and display box
	1 evaluation envelope
	16 transparencies
	1 What Happened? picture
	1 Sunflower Response to Light chart
	1 Lettuce and Tomato Response to Light chart
	1 Temperature and Plant Development chart
	1 Evaluating Melon Growth in Water chart
	1 Measuring Melon Growth in Water chart
	1 Outdoor Changes Graphs and Chart sheet
	1 Isopods' Response to Temperature graph
	1 Isopods' Response to Light graph
	1 Isopods' Response to Water chart
	1 Crabs' Response to Temperature chart
	3 sheets chart paper
	1 Everglades picture, large
	16 Everglades pictures, small
2	15 plastic troughs
	32 trough inserts
	15 metal straps
	15 trough covers
	1 set of Live Organisms Shipments order forms
3	5 light/heat source bulb support rings
	15 tumbler supports
	15 metal cylinders
	5 ten-cm aluminum pans (for light/heat source)
	32 twistems
	3 plastic bags
	16 scoops
	3 sheets adhesive dots, green
	5 sheets adhesive dots, red
	1 sheet adhesive dots, black
	1 sheet labels
	16 rulers
	2 packages fava beans
	1 package sunflower seeds
	1 package tomato seeds
	1 package lettuce seeds
	1 package bush bean seeds
	1 package melon seeds



Drawer	Item Description and Quantity
4	4 six-liter containers
	8 container lids
	4 water sprinklers
	16 tumblers
	5 tumbler lids
	32 thermometer stems and backs
	40 wooden sticks
	32 planter sticks
	2 extension cords
	16 medicine droppers
5	4 six-liter containers
	4 water sprinklers
	32 planter cups
	32 planter bases
	16 vials
	1 package fertilizer

In outer shipper:

5 light/heat sources (5 socket-shade assemblies, 15 legs)

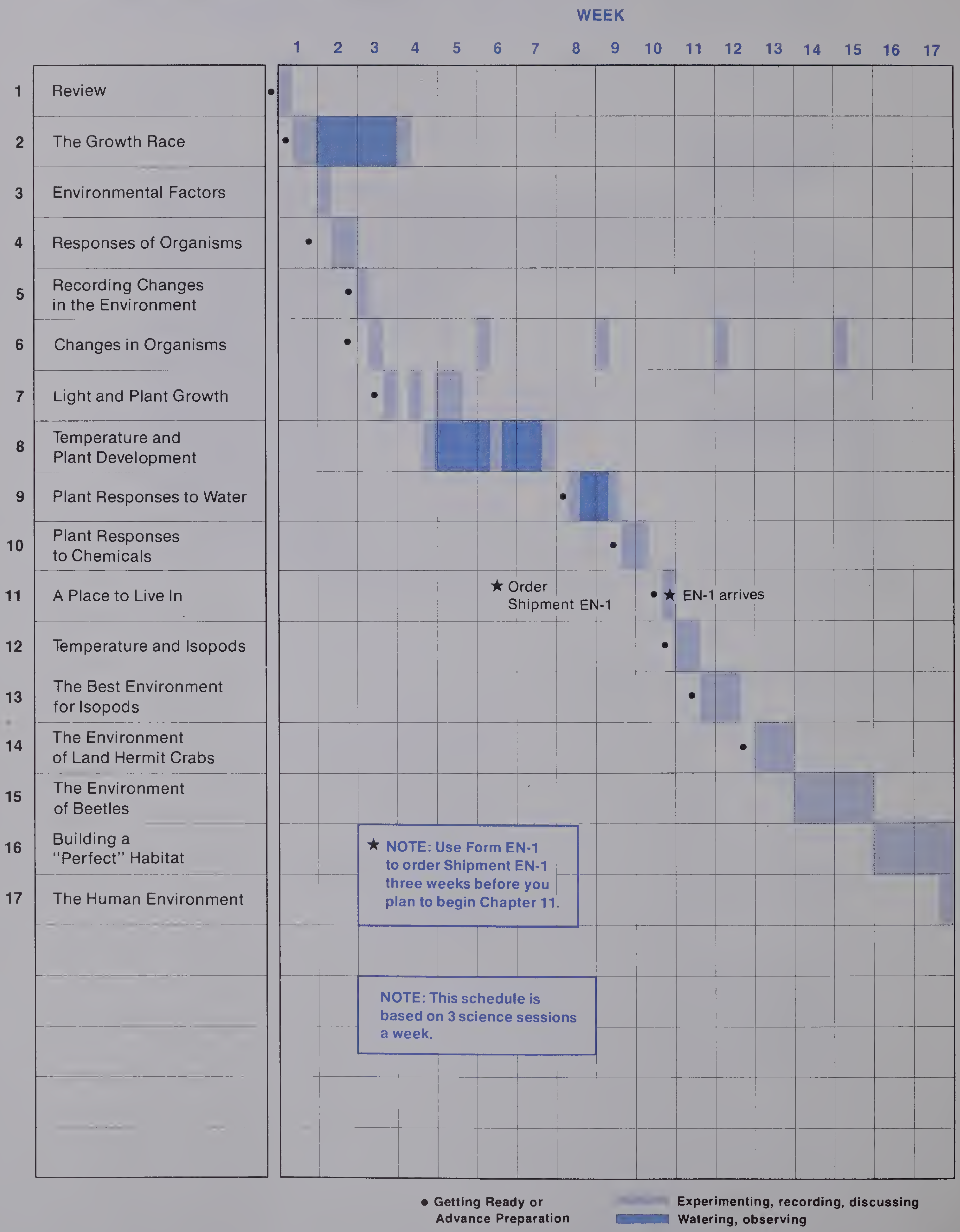
Sand and Soil box

5 bags of soil

Live Organisms Shipment EN-1

75 beetles
20 land hermit crabs
80 isopods

Environments Schedule of Activities



★ **NOTE: Use Form EN-1 to order Shipment EN-1 three weeks before you plan to begin Chapter 11.**

NOTE: This schedule is based on 3 science sessions a week.

● **Getting Ready or Advance Preparation**

▨ **Experimenting, recording, discussing**

■ **Watering, observing**

DATE DUE SLIP

DUE EDUC JAN 20 '83

RETURN JAN 23 '83

DUE EDUC OCT 10 '83

RETURN OCT 5 '83

MAR 16 RETURN

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